MECHANICAL ENGINEERING

June 1960

A SPECIAL REPORT

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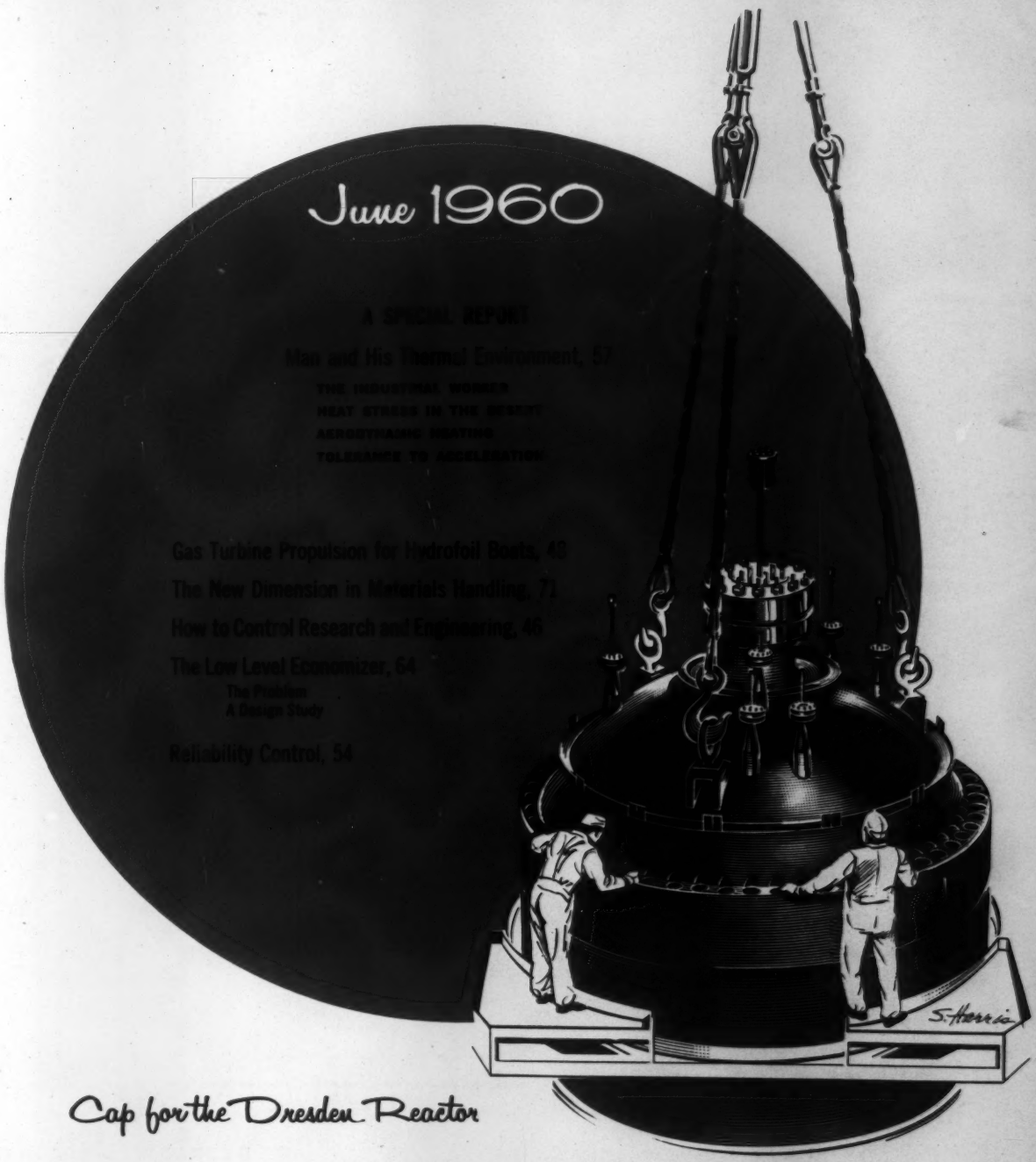
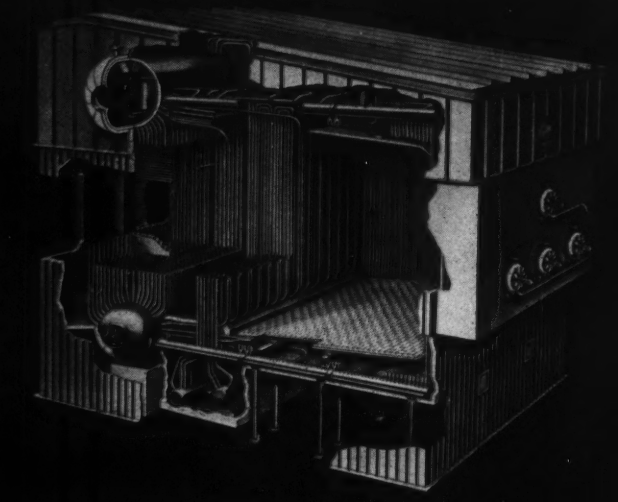
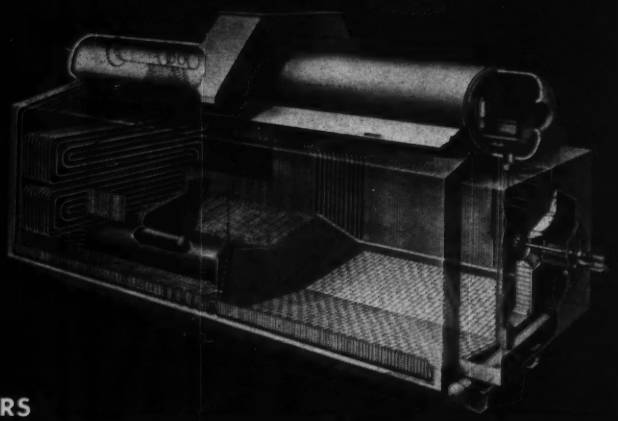


Cap for the Dresden Reactor

B&W INTEGRAL-FURNACE BOILER, TYPE PFI—The PFI, B&W's new Integral-Furnace Boiler, produces steam in the general range of 80,000 to 400,000 pounds per hour. Oil or gas, or a combination of both, can be used as fuel. In power, process or heating applications, the pressure fired PFI assures clean, dependable steam over a wide load range. The drainable superheater, at left center, permits the draining of water after a shut down, facilitating easy storage and simple, safe start-up. Generous tube spacing prevents ash or slag pluggage of the superheater. The burners at extreme right are centralized for easy observation and adjustment, while the integral combustion air duct at the top of the unit saves space.



B&W INTEGRAL-FURNACE BOILER — TYPE FO — B&W's new package boiler offers economy, convenience and quality at capacities from 60,000 to over 100,000 pounds per hour. A natural circulation boiler, the FO combines the advantages of the package boiler with the proved reliability of B&W Integral-Furnace design. The FO Boiler has a completely water-cooled furnace of ample volume, and is designed to provide steam at pressures from 250 to 775 psi at temperatures up to 750 F.



B&W INTEGRAL-FURNACE BOILERS
. . . range in size from shop assembled "package" units (5,000 to 100,000 lb hr) to field erected units for capacities up to 400,000 lb hr.

STEAM FOR INDUSTRY

. . . from Babcock & Wilcox Integral-Furnace® Boilers.

Steam for industry can be produced most efficiently with units designed and constructed by Babcock & Wilcox, the nation's most experienced company in its field.

B&W's engineering progress provides a range of steam capacities, pressures and temperatures that can solve your particular requirements. Modern B&W Integral-Furnace Boilers embody the operation, design and maintenance features that assure efficiency, economy and availability of clean, dry steam for any use.

For new plant installation, expansion of present facilities or replacement of obsolete units, ask B&W's engineering staff for their recommendations. They'll be happy to help you work out the best solution. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

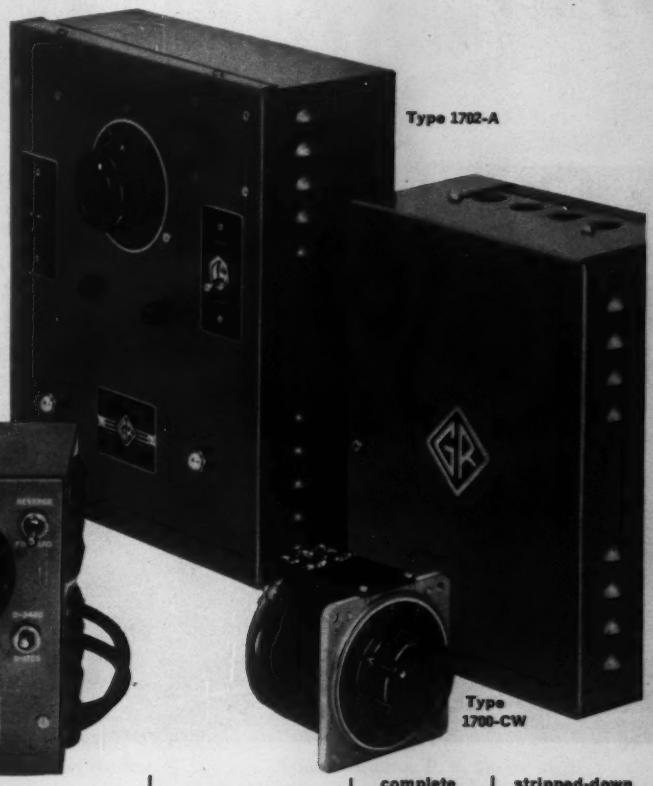
G-966-IB

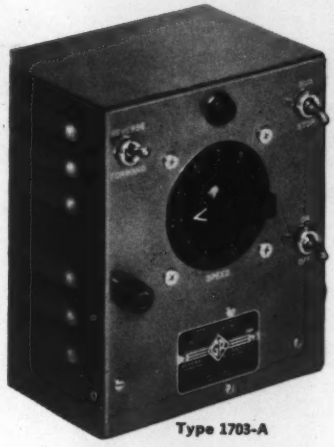
Need a Motor Speed Control that . . .

- ★ Delivers rated torque over wide ranges of speed without causing pulsation or chatter?
- ★ Requires no warm-up, is smooth starting, and has high initial torque?
- ★ Can be instantly started, stopped, or reversed at any load?
- ★ Has long life?

General Radio Variac® Motor Speed Controls have all these features. They are designed to operate d-c motors from a-c lines. Thus, they combine the excellent starting characteristics and good regulation of d-c shunt- and compound-wound motors with all the conveniences of a-c operation.

Ten models . . . in sizes from 1/15 hp to 3/4 hp . . . can be purchased complete or in stripped-down styles for installation by original equipment manufacturers . . . quantity discounts apply . . . motors available.





	speed range	complete model	stripped-down model
for shunt motors 1/15 hp or less	0 to rated 0 to 2x rated	1701-AK $95	1701-AKW $72
for shunt motors 1/15 hp or less	0 to rated	1701-AM $95	—
for series or universal motors 1/15 hp or less	0 to rated	1701-AU $95	—
for shunt or compound motors 1/12 hp to 1/6 hp	0 to rated 0 to 1.25x rated 0 to 1.5x rated	1703-A $110	1703-BW $90
for shunt or compound motors 1/4 hp to 1/3 hp	0 to rated 0 to 1.15x rated	1700-B $180	1700-CW $155
for shunt or compound motors 1/2 and 3/4 hp	0 to rated 0 to 1.15x rated	1702-A $255	1702-BW $215

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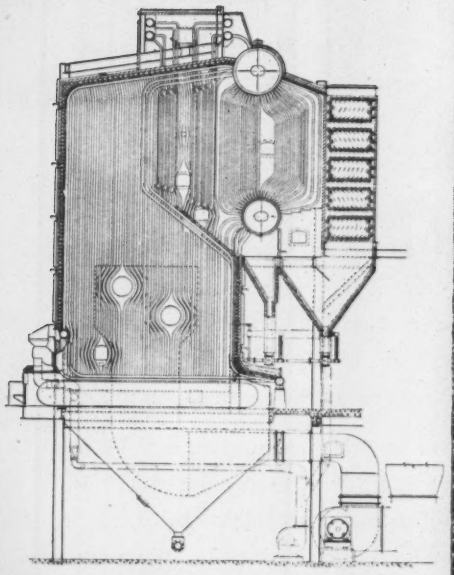
FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

MORE INFORMATION: Many types and sizes of Union Steam Generators are described in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pennsylvania.

UNION

steam generators

MECHANICAL ENGINEERING

PUBLISHED BY
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS

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REGIONAL ADVISORY BOARD

THE COVER

Bolt it down and produce steam. This is the 50-ton head for the reactor vessel of the 180,000-kw Dresden Plant designed by General Electric. The massive top was bolted to the vessel by 56 5-in-diam bolts. The plant, 50 miles southwest of Chicago, is the world's largest privately financed, all-nuclear plant and was built for Commonwealth Edison and the corresponding Nuclear Power Group, Inc. See editorial, page 45.

HOW TO CONTROL RESEARCH AND ENGINEERING.....**S. R. Irish** 46

You're at sea when you try to judge the progress of research and engineering. Yet management must set up controls for projects on which huge sums are to be spent. Here is the managerial approach.

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RELIABILITY CONTROL.....**F. A. Thompson** 54

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Heat Stress in the Desert.....**Austin Henschel and H. E. Hanson**

Aerodynamic Heating.....**Paul Webb**

Tolerance to Acceleration.....**B. F. Burgess, Jr.**

You think first of aerodynamic heating, the airman's exposure to high temperatures. But there is also the heat stress imposed on workers in industry. When does it pay to air condition your plant?

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The Problem.....**Stan Jewson**

A Design Study.....**J. H. Potter and R. C. King**

The problem: Higher operating efficiency. The points of attack: Heat utilization (higher working temperatures, plus reheat); and corrosion (new acid-resistant metals for flue-gas economizers).

THE NEW DIMENSION IN MATERIALS HANDLING.....**C. W. Drake** 71

Creative engineering goes beyond gadgets, seeks solutions in terms of over-all concepts. The materials-handling engineer finds that optimum solutions frequently call for a minimum of hardware.

Contents continued on following page

FOR AVAILABILITY SERVICE QUALITY SPECIFY

B&W *Job-Matched stainless tubing*

You're assured these important advantages:

- **Availability:** A nationwide network of district sales offices and steel service centers, plus 2 B&W mills—each equipped to serve you promptly from a broad range of tube sizes, grades and finishes.
- **Service:** B&W's thorough understanding of process industry requirements makes possible sound engineering assistance on all types of tube applications.
- **Quality:** Comprehensive quality control assures uniformity of tube properties and conformity to specifications on every order. All tubing is carefully matched to your fabricating and end-product requirements.

These are just a few of the many reasons why it pays to specify B&W Job-Matched Stainless Tubing. And remember—matching tubes to jobs assures you the *right tube,* in the *right quantity,* at the *right time.* For more information call your local B&W District Sales Office, or write for Bulletin TB-410. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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MECHANICAL ENGINEERING

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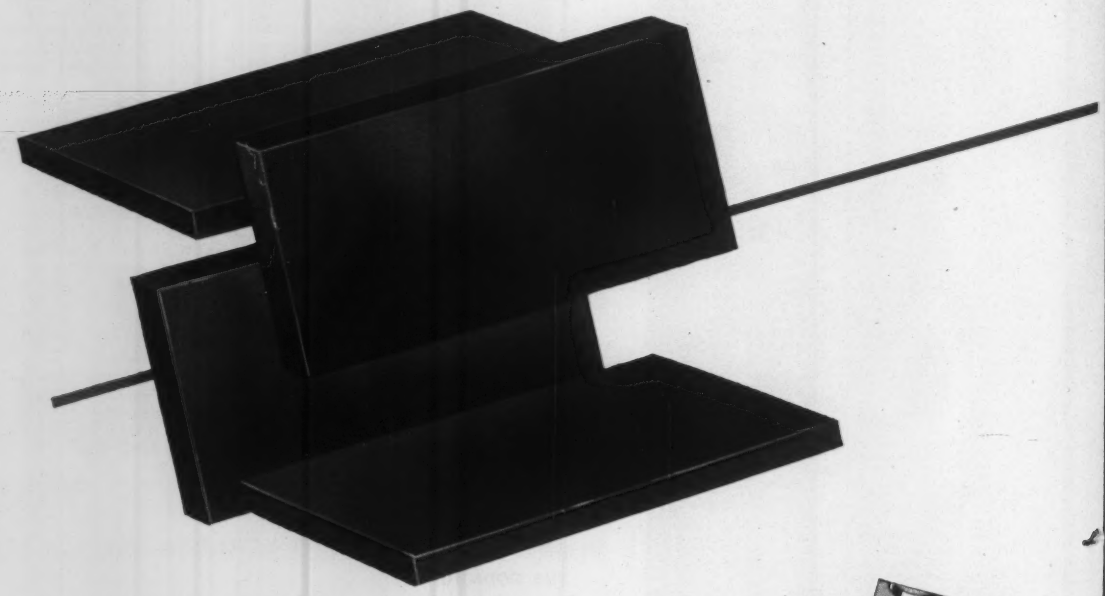
GRAPHITAR® VANES

(CARBON-GRAPHITE)

and long life of CONDE

This rotary positive displacement pump, engineered and produced by the Dri-Air Pump Department of the Conde Milking Machine Company, Inc., of Sherrill, N. Y., is designed to deliver clean, dry air or gas for high vacuum and low pressure applications in hospitals, dental offices, chemical or pharmaceutical plants, industrial processing systems and in metalworking plants. Thanks to vanes of GRAPHITAR, the CONDE Dri-Air Pump gives years of trouble-free, continuous operation at maximum recommended vacuum and speed . . . *without lubrication!* The GRAPHITAR pump vanes are self-lubricating and are seated by centrifugal force. Operating with a minimum of friction, they become increasingly efficient as the pump is used. In addition to their self-lubricating properties, the GRAPHITAR vanes are hard, light, non-sticking, non-warping and chemically inert. Perhaps these qualities can be utilized to advantage in your products.



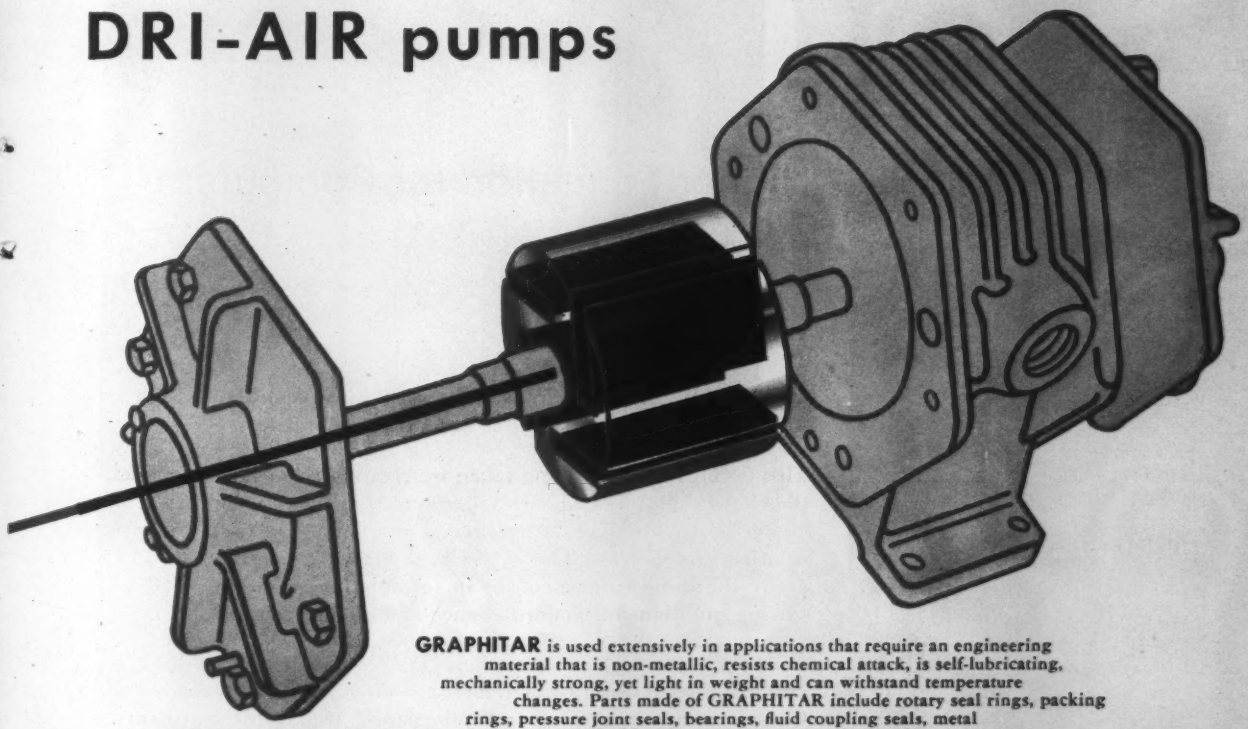
Bulletin #20 includes detailed design data along with properties, characteristics and typical applications of GRAPHITAR. Write for your free copy. If you have questions concerning the incorporation of GRAPHITAR parts in your products, our engineers will be glad to assist you.

THE UNITED STATES

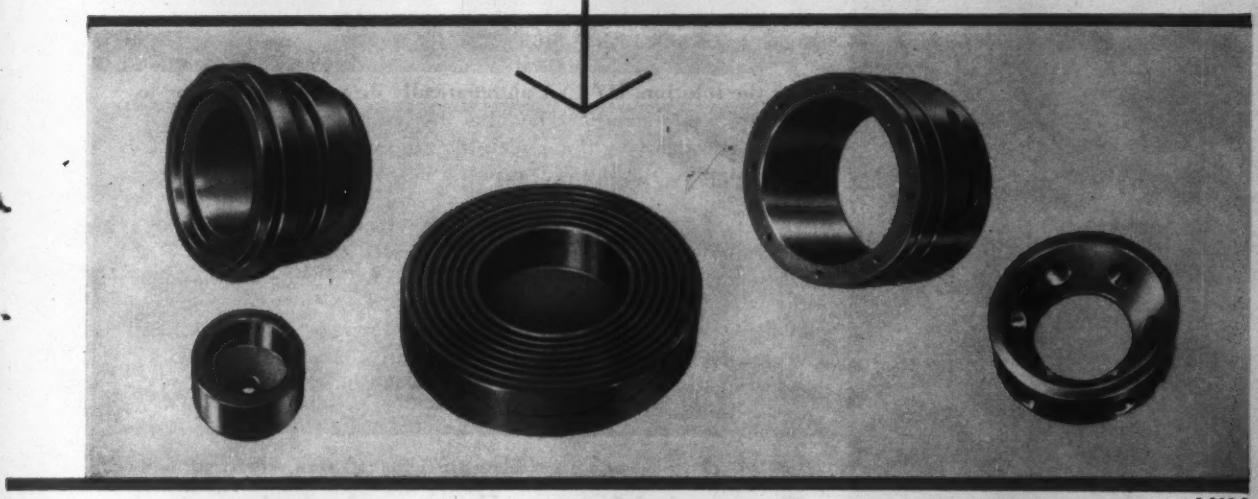
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

help insure efficiency

DRI-AIR pumps



GRAPHITAR is used extensively in applications that require an engineering material that is non-metallic, resists chemical attack, is self-lubricating, mechanically strong, yet light in weight and can withstand temperature changes. Parts made of GRAPHITAR include rotary seal rings, packing rings, pressure joint seals, bearings, fluid coupling seals, metal backed bearings, piston rings and pump liners.



R-285-2

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

One of a series

Higher Education for Computers

"Let's put the computer in at the start of a problem, rather than just having it buzz through the computations."

This is the approach being taken by computer specialists at the General Motors Research Laboratories as they explore ways of giving large-scale digital computers a greater role in the solution of problems. The object is to "teach" computers to apply the same rules men use in formulating, analyzing, and solving questions of modern science and engineering.

A recent outgrowth of this work is DYANA, GM Research's new automatic analysis and programming system. DYANA is one of the first computer systems to "understand" declarative statements. For a large class of dynamic problems, the engineer can simply describe his physical system to the computer. The computer figures out how to handle it.

For the solution, DYANA automatically directs the computer to prepare a mathematical model of the system, to write its own program for solving the model, then to execute the program and compute the desired answers.

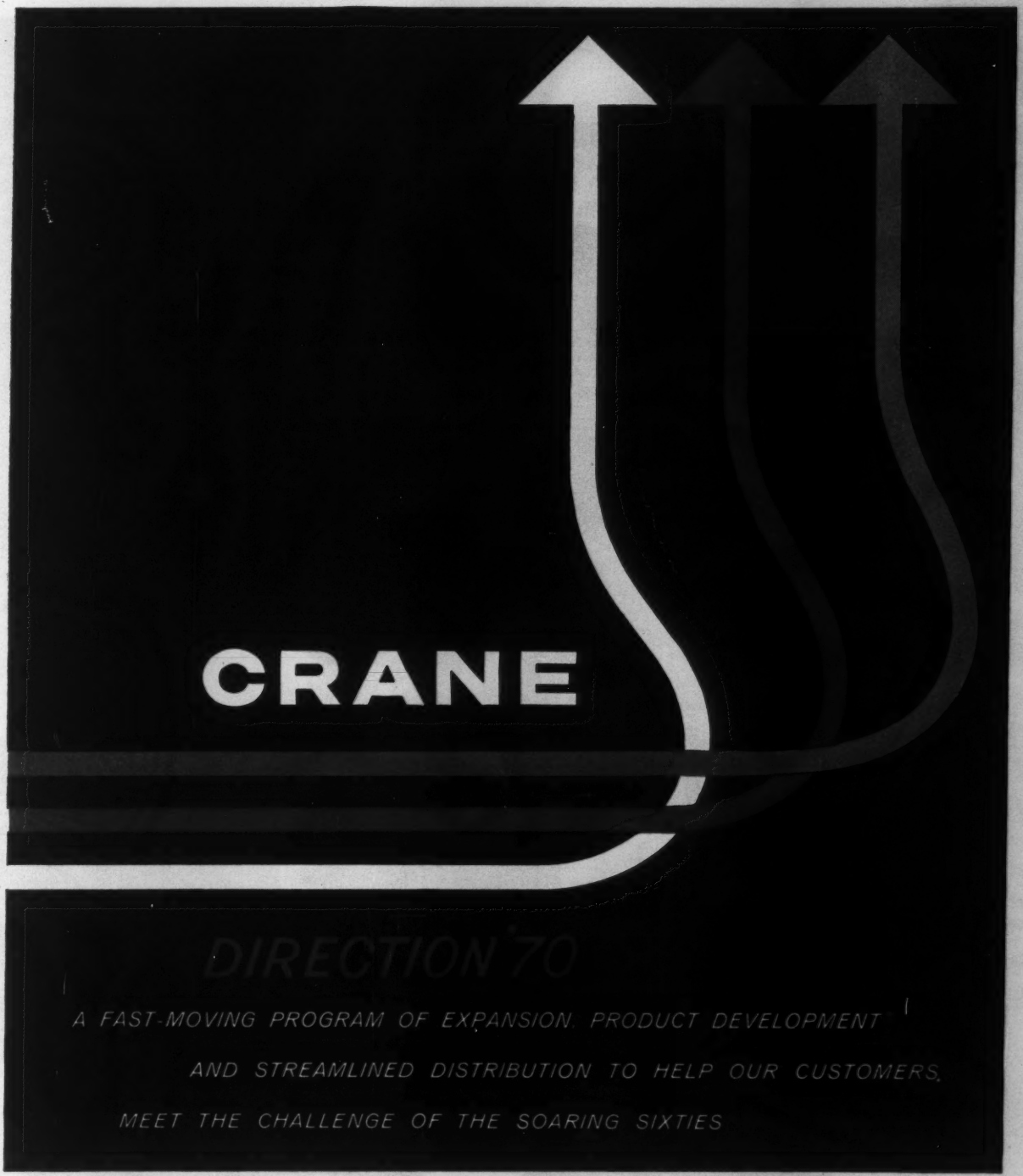
The higher education of computers currently involves studies in symbol manipulation, problem-oriented languages, character and pattern recognition, and engineering simulation.

Such advanced computer concepts are giving General Motors professional people more time for creative engineering and research—time to explore ideas and to develop "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

Comparison of program tapes for a vibrational problem expressed in DYANA language, in algebraic-oriented language, and in the basic machine language.

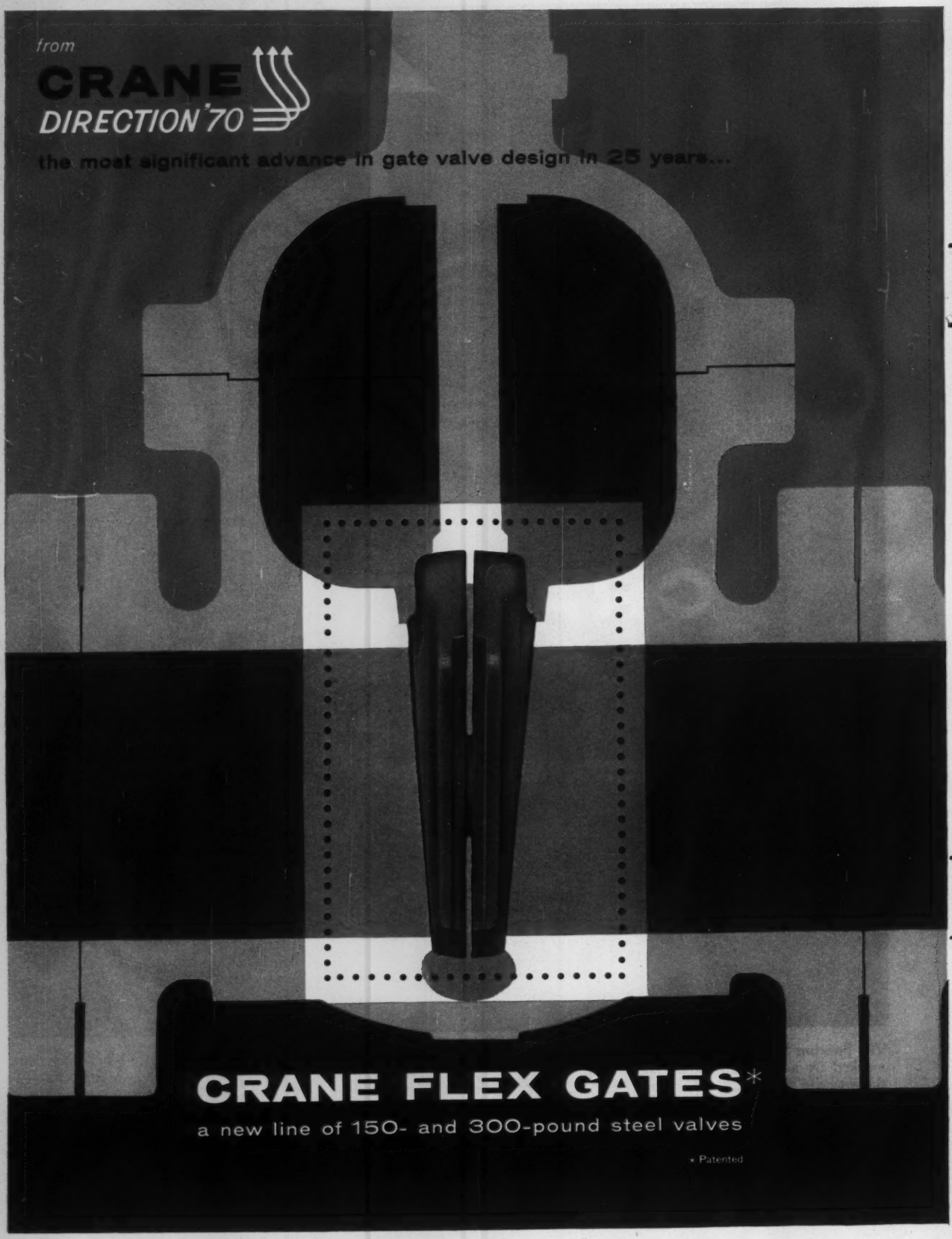

CRANE
DIRECTION '70
A FAST-MOVING PROGRAM OF EXPANSION, PRODUCT DEVELOPMENT
AND STREAMLINED DISTRIBUTION TO HELP OUR CUSTOMERS
MEET THE CHALLENGE OF THE SOARING SIXTIES

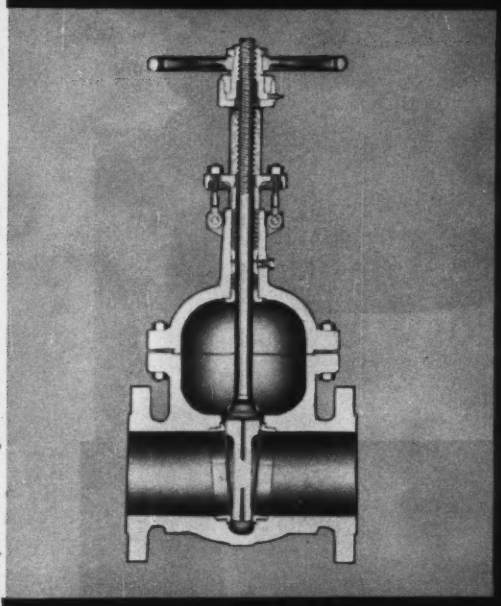
The Soaring Sixties have begun. This is the decade to be marked by accelerated industrial growth. By 1970, predictions are that...

- machinery production will double
- petroleum production will increase 4% to 5% each year
- chemicals are to double their present output at the current compound growth rate
- food processing will rise nearly 40%, paper and allied industries will expand about 60%

Total industrial production is estimated to rise some 60% in the next ten years. Looking at it another way, the prospective *increase* in manufacturing and mining is almost as large as the total output of just 12 years ago.

Crane announces Direction '70... new products to help industry meet the challenge of the Soaring Sixties. These are products to improve quality control. These are products to increase production. These are products to help you control your costs. On the following pages is the first... the most significant Gate Valve improvement in 25 years. It's the first announcement of many you'll be seeing from Crane in Direction '70.


from
CRANE
DIRECTION '70
the most significant advance in gate valve design in 25 years...
CRANE FLEX GATES*
a new line of 150- and 300-pound steel valves
* Patented



Instead of being made with a solid disc, new Crane Flex Gates have separate disc faces, connected by the spool-like unit you see in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

FLEXIBILITY PROVIDES THESE BENEFITS

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque . . . will not stick closed even in high temperature service.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs. And they have been exhaustively field tested.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be serviced—body seat rings replaced or seating faces refinished—quickly without painstaking accuracy. Slightly off-taper seats do not affect tightness or operating ease.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes 12 inch and smaller; 150- and 300-pound pressure classes.

• • • • •

Ask your nearby Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information *and* products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

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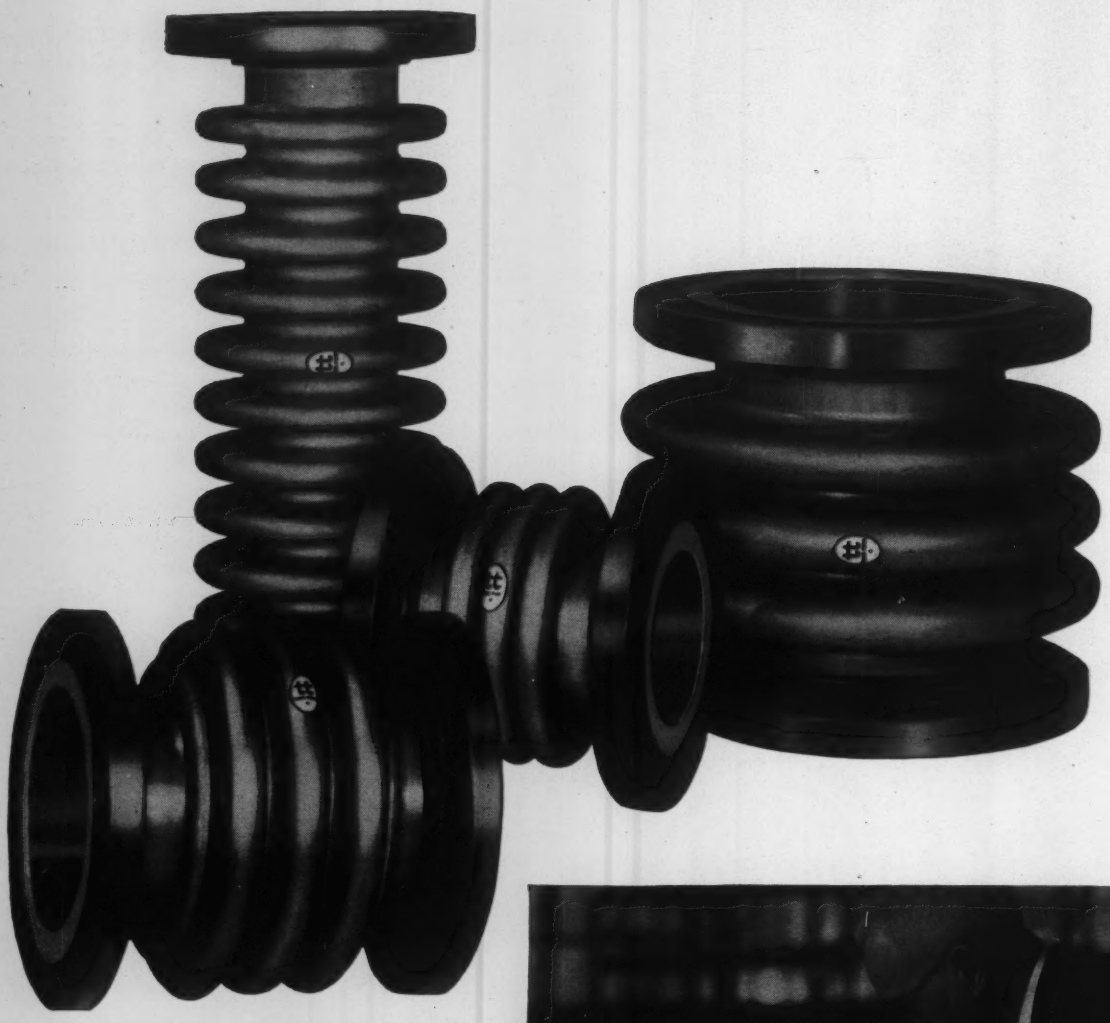
VALVES • ELECTRONIC CONTROLS • PIPING
PLUMBING • HEATING • AIR CONDITIONING

NEW...FROM

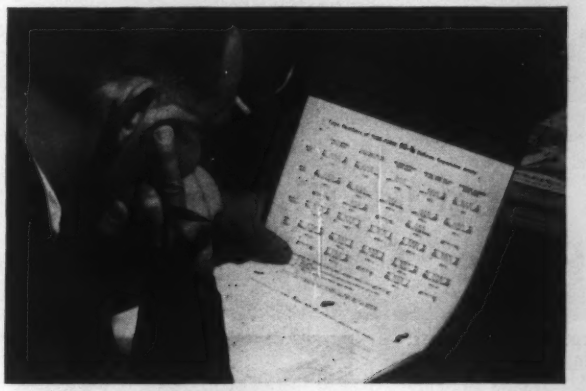


TUBE-TURN *Bellows Expansion Joints are test rated on basis of minimum cyclic life.*

TUBE TURNS...

Bellows Expansion Joints test rated for assured cyclic life

Tube Turns has introduced a brand new concept in bellows expansion joints to fill a vital need in engineered piping systems.

These new bellows joints are rated on the basis of thorough, well organized test studies to *assure a definite minimum cyclic life*... rather than the usual average or maximum. This conservative rating, backed by Tube Turns' extensive test results, gives you an assurance of *confidence* heretofore lacking in the application of bellows joints.

Hence, you can specify TUBE-TURN* Bellows Expansion Joints and be sure of predictable performance. These top-quality products will be subject to the same warranties that apply to all other products of Tube Turns.

Backed by Tube Turns' technical service! This new line of products is backed by 31 years of pioneering research in piping technology, including problems of piping flexibility. Our sales-engineering representatives, located nearby, will assist in the application of TUBE-TURN Bellows Expansion Joints to your specific problems.

Complete line. TUBE-TURN Bellows Expansion Joints are available in sizes 3" through 30"... unreinforced, rated 50 psi... reinforced, rated 275 psi. Also, expansion compensators for steam and hot water service are available in sizes ¾" through 3". Mail coupon for complete information.

*The trademarks "TUBE-TURN" and "tt" are applicable only to the quality products of Tube Turns.

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*Company Name*_____

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*City*_____ *Zone*____ *State*_____

*Your Name*_____

*Position*_____

Hot reheat pipe of new 325,000 KW unit No. 5 at Pacific Gas and Electric Company's Pittsburg Power Plant in California, showing line-up of 3 Grinnell Constant Support Hangers.

Grinnell Hangers support piping at Pittsburg Power Plant

Grinnell manufactures a complete line of engineered pipe hangers and supports. Where reactive forces at terminal points must be kept within specified limits, Grinnell Constant Support Hangers are recommended. They are designed to provide an exact supporting force equal to the pipe load throughout the entire range of travel.

When pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant support type, Grinnell Variable Spring Hangers are recommended. They should be designed to support not less than 85% or more than 120% of the designed load for the total travel.

When necessary to prevent abnormal movement or vibration in pipe lines, Grinnell Sway Braces of the energy-storing, instant-acting, counter force type are available.

Grinnell maintains a staff of trained technicians; provides highly skilled assistance and advice right from the design stage; offers experienced field engineering service. Call on Grinnell next time. Grinnell Co., 277 West Exchange St., Providence 1, R. I.

Closeup of Grinnell Variable Spring Hanger supporting boiler feed pipe.

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AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

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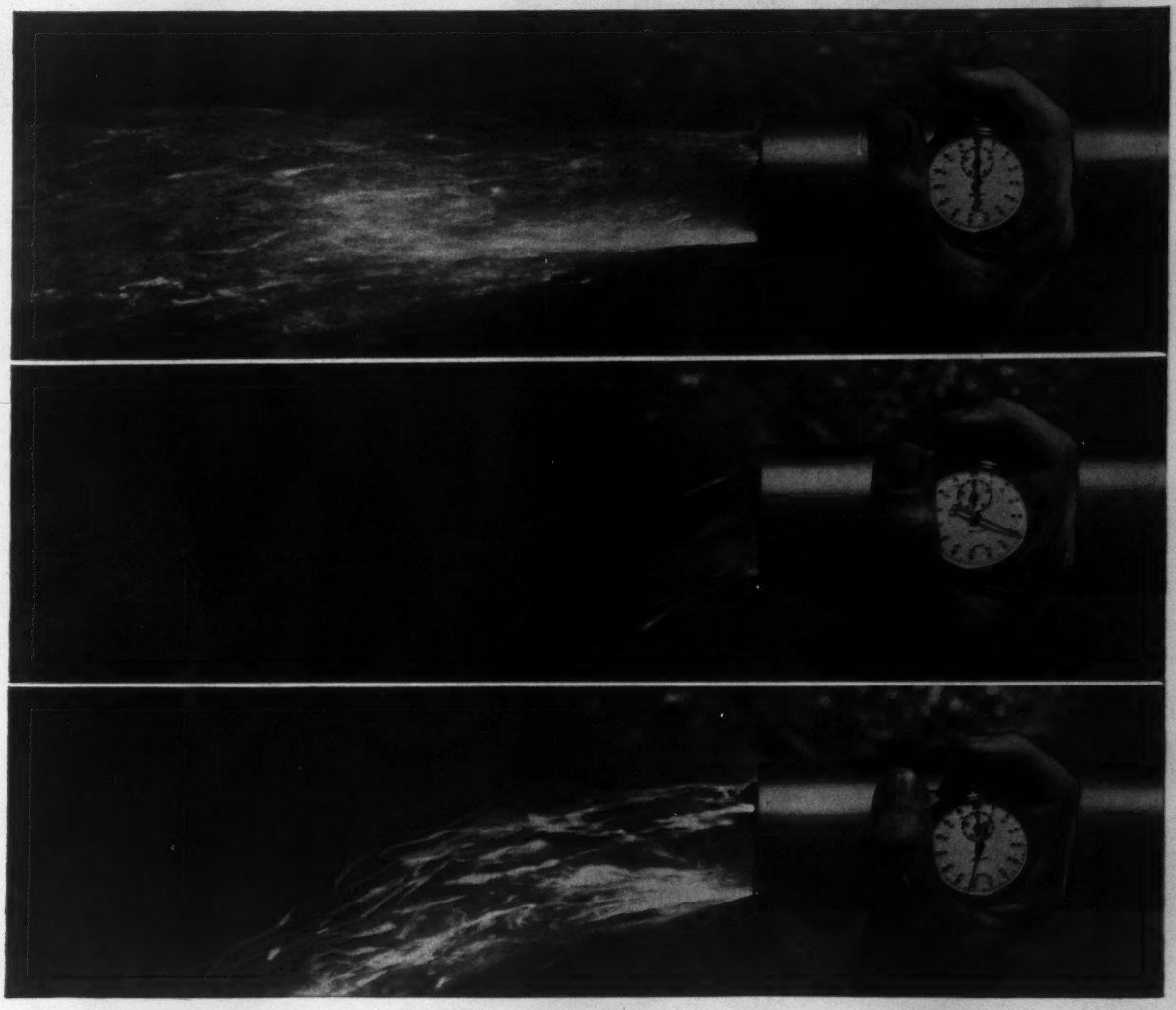


Now for processing applications—Adjustable-Capacity, Adjustable-Pressure

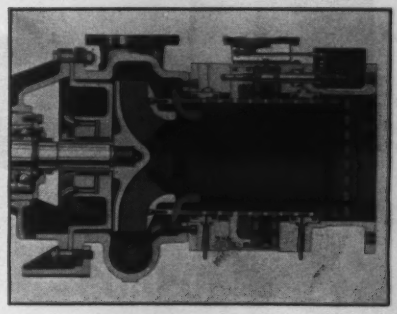
pumps regulate flow...without valves

Here's a pump that lets you regulate flow without changing pump speed and eliminates the need for valve throttling. It also improves mixing, reduces air binding, eliminates plugging and saves power.

It's the versatile *ACAP* pump . . . proved for 6 years in the pulp and paper industry. Now available in sizes suitable for other processing applications . . . capacities from 50 to 45,000 gpm, heads to 270 feet.

The change in capacity and head is related to the clearance between the *ACAP* cylinder (shown in orange) and the impeller. The pump can be adjusted automatically by means of a new internal pneumatic control system or by simple manual operation. Pump is available in any cast material.

For complete details, call your nearby A-C representative. Or write ***Allis-Chalmers,*** *Industrial Equipment Division, Milwaukee 1, Wis.*



ACAP is an Allis-Chalmers trademark.

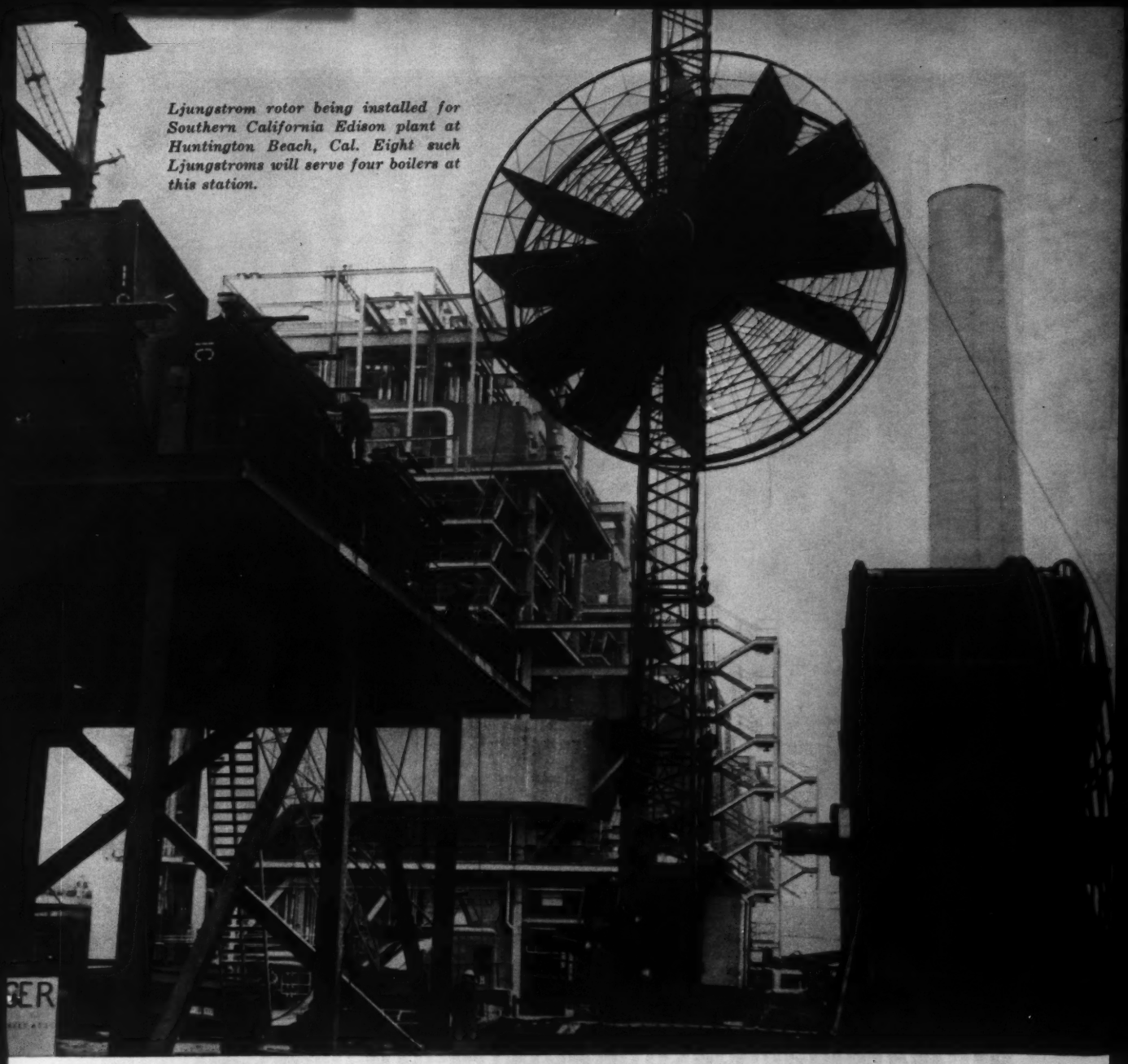
Although Jeffrey patented the principle years ago, STR (Steel Thimble Roller) chain has been constantly improved by Jeffrey to keep pace with industrial progress. Components are designed, materials selected, machined and heat treated to give maximum strength, shock resistance and wearability with minimum weight.

Jeffrey STR chain provides a positive yet flexible means of transmitting power for unit machinery and general industrial drives, and for heavy duty elevating and conveying service. Jeffrey offers four classes to meet various operating conditions.

Ask for engineering assistance on the application of STR chain to suit your needs. The various classes of STR chain are in stock, ready for immediate shipment to you. Chain also can be tailor-made to fit your particular requirements. The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY... CONTRACT MANUFACTURING



Ljungstrom rotor being installed for Southern California Edison plant at Huntington Beach, Cal. Eight such Ljungstroms will serve four boilers at this station.

AIR PREHEATER SERVICE WILL STILL BE IN EFFECT ON THESE UNITS IN THE YEAR 2000

These new Ljungstrom® Air Preheaters, being installed at Southern California Edison's Huntington Beach Station, will be protected by an unusual service policy, one that guarantees regular inspection by Air Preheater engineers throughout the life of each unit.

There's no terminal date on this service — it's in effect as long as the units are in operation. In fact, Lifetime Air Preheater Service is still helping to keep the first Ljungstrom installation in the U.S. running perfectly, although it's been in operation almost 40 years.

Air Preheater provides first-rate *factory* service too. In one instance, in response to a last-minute decision to replace cold-end elements near the end of a scheduled shutdown, Air Preheater *fabricated and shipped* over 13,000 pounds of heating elements the day after the order was received.

Regular inspection and fast factory service are just two of the advantages Air Preheater offers its customers. Another is expert knowledge of boiler and preheater problems, gained through 35 years' experience. This combination—knowledge of customer problems and a *continuing* interest in them — probably explains why nine out of ten preheaters sold today are Ljungstroms.

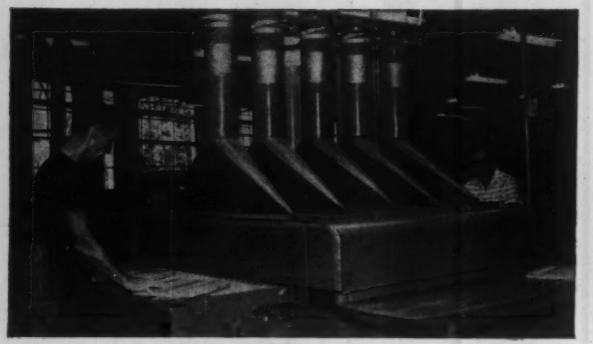
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

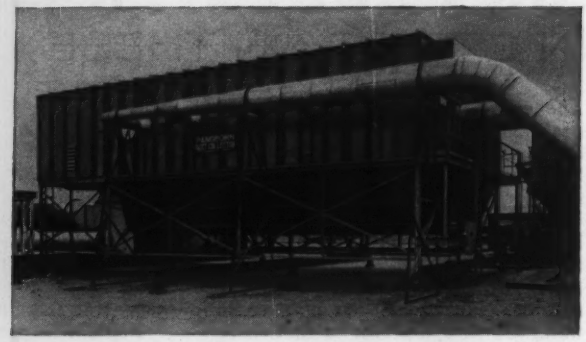
Operation: Dust Control

(One of a series)

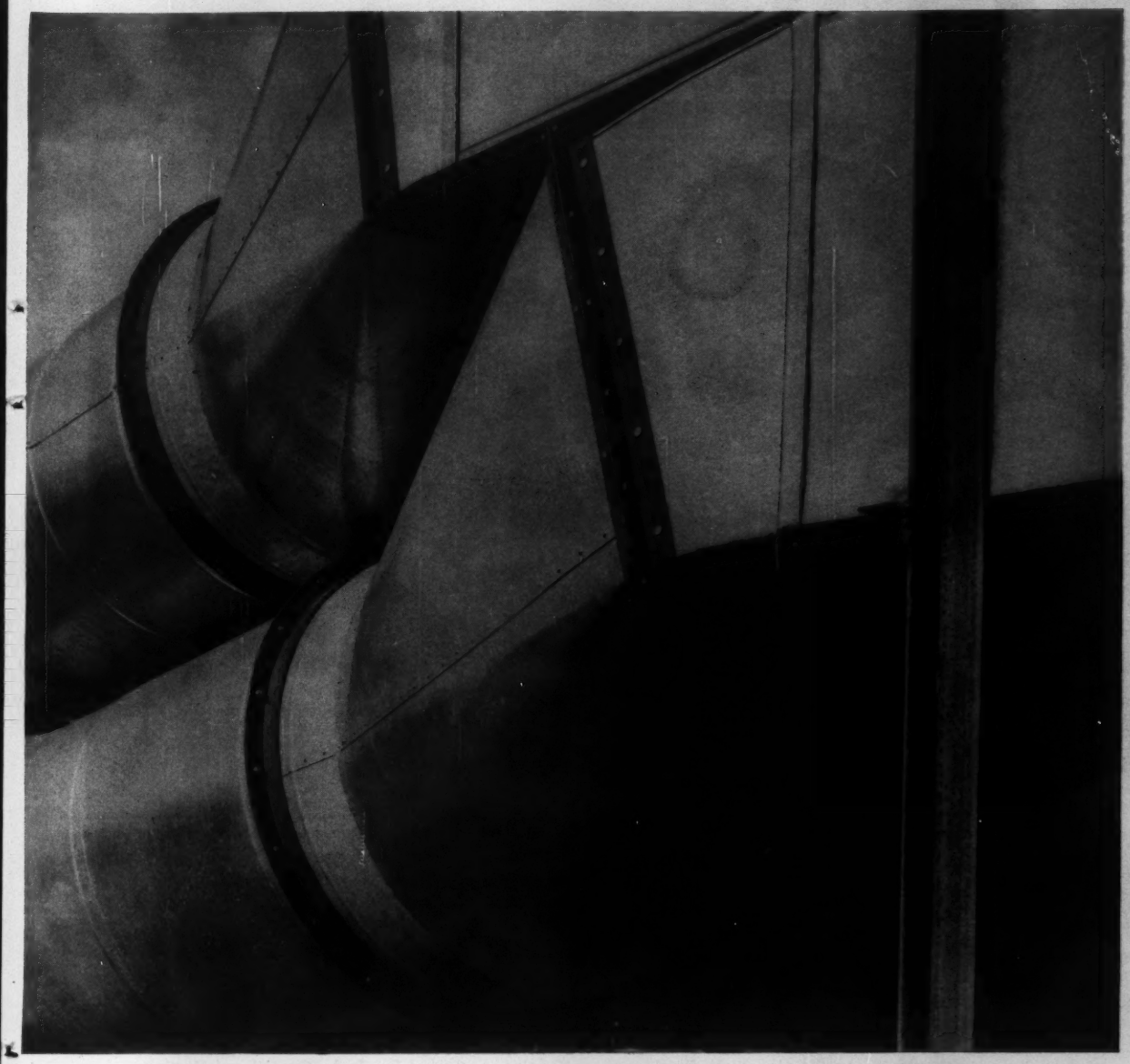
At National Cash Register, 10 tons of wood



Dust is trapped at the source by hoods engineered for the individual job . . .



. . . and is piped from 160 locations to five giant Pangborn Cloth Bag Collectors.



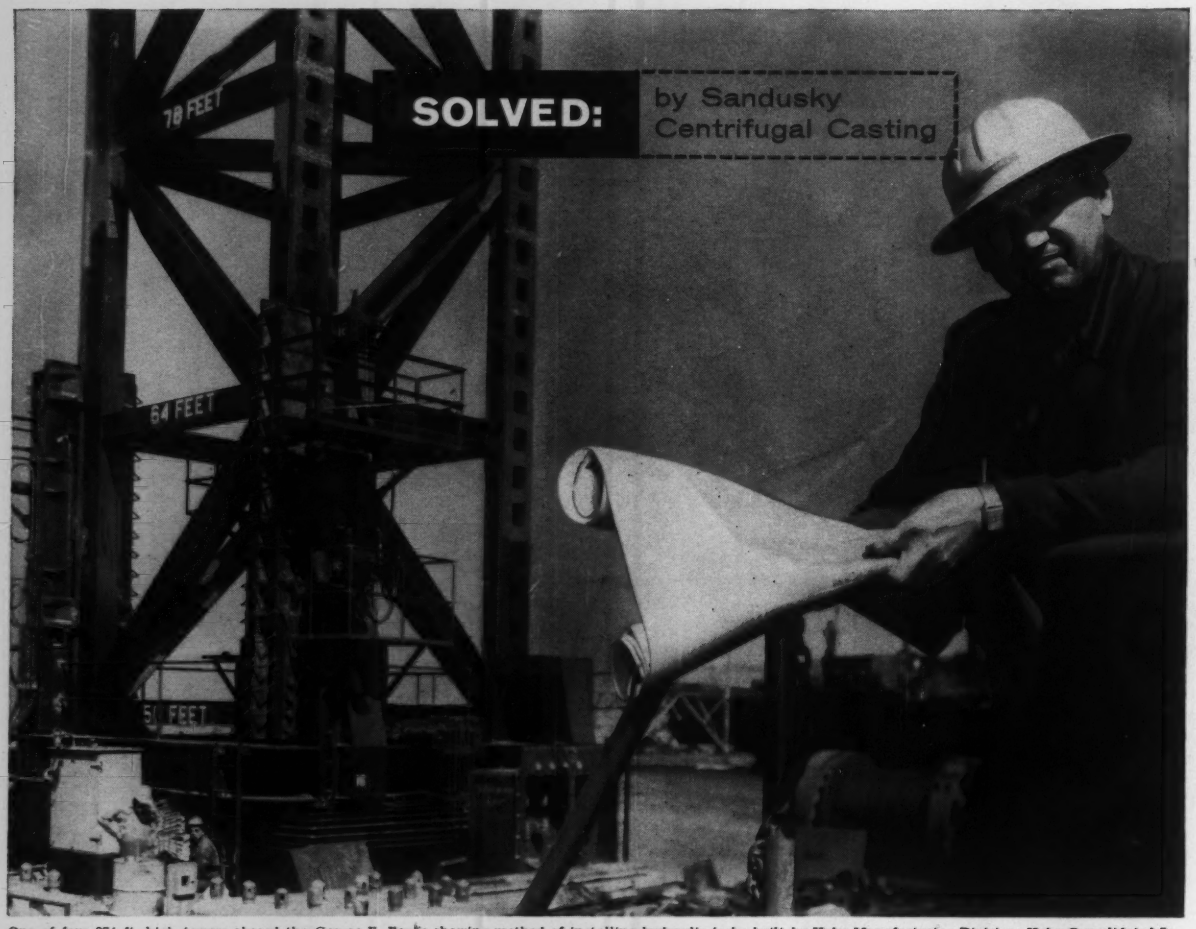
shavings, chips and dust are collected daily!

Mammoth is the word for the 5-floor woodworking plant of National Cash Register headquarters, Dayton, Ohio. Processing nearly 300,000 sq. ft. of lumber each month, this operation generates 10 tons of waste material per day.

To protect NCR employees, equipment, plant and neighborhood, five Pangborn Cloth Bag Dust Collectors trap 90 cu. ft. of fine dust for disposal and, during the winter months, permit recirculating of the already-heated, cleaned air. This efficient performance of Pangborn Dust Control saves thousands of dollars in heating costs during the cold weather. In addition, a neighborhood and health nuisance has been eliminated; equipment maintenance and plant housekeeping costs have been minimized.

Dust a continuing problem in *your* plant? Talk to the Pangborn man in your area or write: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control, Blast Cleaning, Vibratory Equipment—Rotoblast® Steel Shot and Grit.®*

Pangborn
OF HAGERSTOWN



One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris*, to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186" lengths, machined to 24" O.D. with 2" thick walls and sectioned into four pieces 43" long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . . COST—saving about half the cost of an alternate method of manufacture . . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

When you need cylinders from 7" to 54" in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

5902

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

MORE MILLIONS OF OPERATIONS

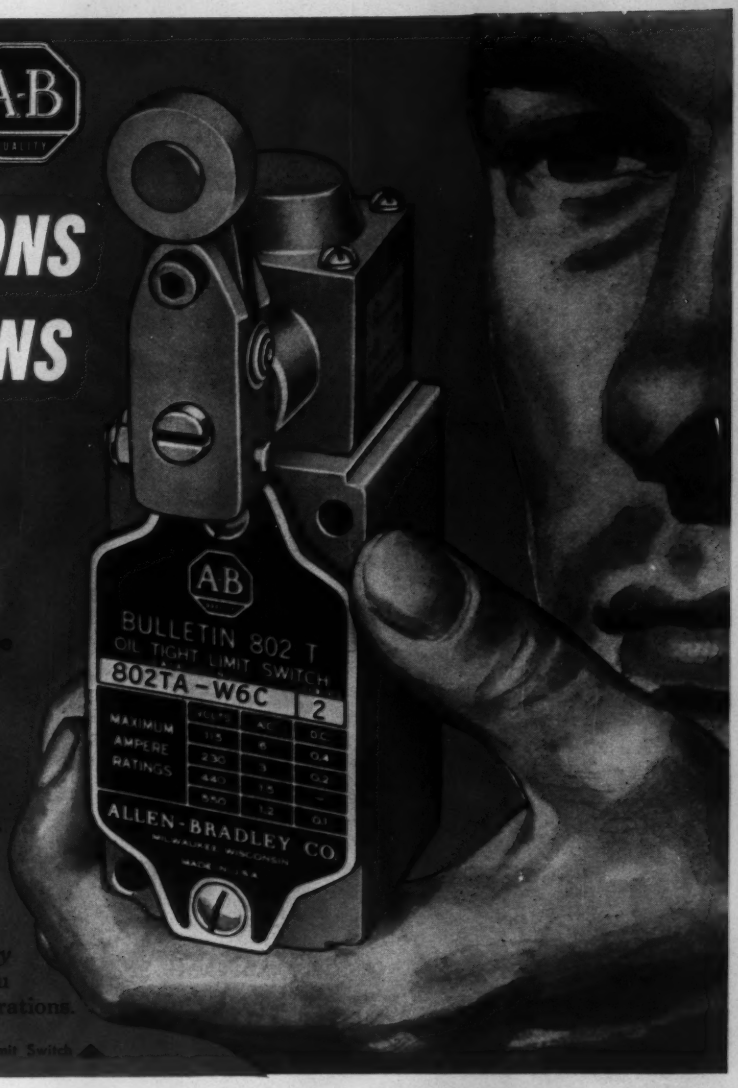
with

Allen-Bradley

Limit Switches

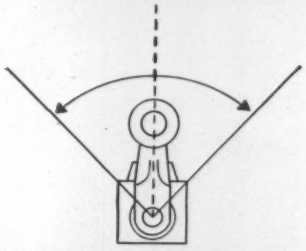
There's nothing now on the market to match the reliability and trouble free performance of Allen-Bradley Bulletin 802T limit switches. They are completely oiltight—operating heads and switch bodies are sealed against oils, coolants, and metal chips. Operators cannot become sluggish or "stick" in operation—contacts cannot become fouled. The double break, silver contacts are always in perfect operating condition—and remain so without maintenance.

Insist on Allen-Bradley—the *quality* line of limit switches that will give you *many more millions* of trouble free operations.

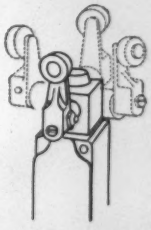


Bulletin 802T Micrometer Adjustment Roller Lever Limit Switch

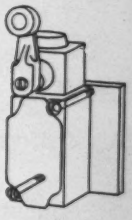
A-B Limit Switch features mean more life, more dependable trouble free service

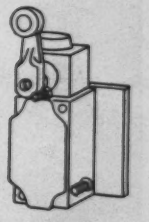


REPETITIVE ACCURACY—Unique toggle blade action assures operation at precisely the same point each time, without adjustment.



FLEXIBILITY—All operating heads can be rotated and fastened in any of four positions 90° apart.





FRONT MOUNTING **REAR MOUNTING**

All Allen-Bradley Limit Switches can be mounted either from the front . . . or from the rear.

Allen-Bradley Co., 1308 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

NEW!
by STOCK

STOCK Equipment Company

announces

a New Volumetric Feeder for Short Center Installations

Outstanding Features:

- Endless belt
- Unobstructed 24" width of coal
- Large depth of coal to enable passage of occasional large pieces or frozen lumps of coal
- Curbs along edges of belt
- Variable speed drive utilizing magnetic slip clutch
- 50 psi explosion pressure housing for feeding pulverizers
- Belt change easily completed in 20 minutes
- Lights and bull's-eyes
- Poke hole next to inlet
- Stainless steel bottom liner
- Swing switch at outlet to stop feeder in event of coal stoppage in downspout to pulverizer
- Swing switch at inlet as required
- Models available for pulverizers and cyclones
- Centerline of inlet to centerline of outlet 2'-8", standard
- Intermediate centers 3'-8", 4'-8", 5'-8" 6'-8", 7'-8".

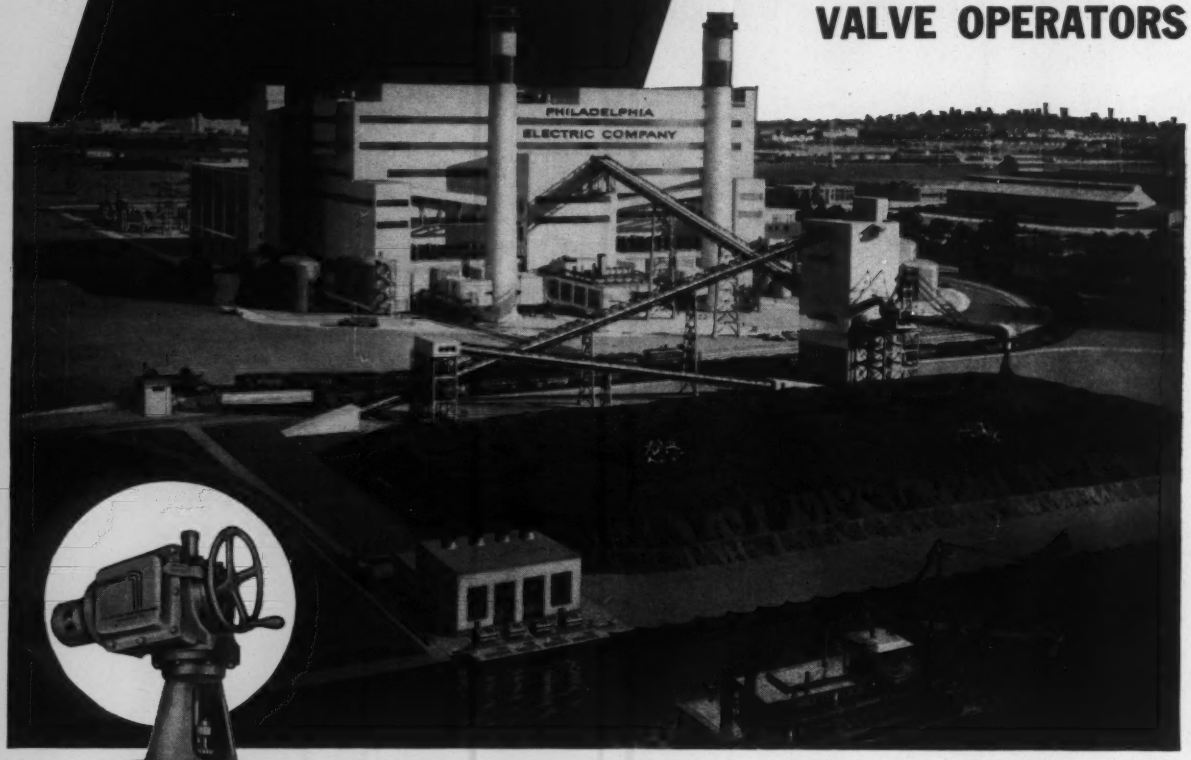
Long Center and Gravimetric Feeders are also available.

For better feeding of coal to pulverizers and cyclones, write to

Equipment Company

729 HANNA BUILDING • CLEVELAND 15, OHIO

New Eddystone Station of PHILADELPHIA ELECTRIC CO. . . . . uses LimiTorque VALVE OPERATORS



This Generating Station is one of the World's most efficient power plants . . . consisting of two 325,000 K.W. Super-critical Pressure Units.

LimiTorque Motorized Valve Operators were chosen for various steam and water applications throughout the Plant. It is significant that LimiTorque is also used in the other Generating Plants of the Philadelphia Electric Company . . . In fact, practically all of the modern generating stations in America use LimiTorque Valve Operators for assurance of dependability, accuracy, safety and economy of operation.

With LimiTorque, one key man can, from a central control point, eliminate all guesswork and labor by opening and closing valves in remote, inaccessible or hazardous locations . . . automatically, speedily, safely and dependably.

LimiTorque is available for actuation by airmotors as well as electric motors.

Should you desire to motorize existing valves of any type . . . contact your valve manufacturer or nearest LimiTorque Sales-Engineering Office.

Send for Catalog L-550 and please use your Business Letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.

Offices in all Principal Cities

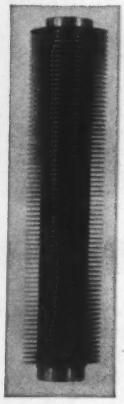
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • King of Prussia, Penna.

NEW LOW SILHOUETTE FANDAIRE AIR-COOLED CONDENSERS

ALWAYS FACED RIGHT —NO MATTER WHAT THE WIND DIRECTION

No need to position circular Fandaire Air-Cooled Condensers to meet prevailing winds. Just set it anywhere for easiest piping.



Exclusive Aimco fintube design provides high-heat dissipating efficiency for circular Fandaire condensers.

Here's the newest, most advanced air-cooled condenser on the market—Fandaire! This modern low silhouette condenser is engineered around a new high-heat dissipating fintube of exclusive design and manufacture. In operation, the entire spiral of fintubing is surrounded with a circle of swiftly moving cool air for highest cooling efficiency. Every degree in temperature drop is fully utilized as this circular design captures the wind from *any* direction, regardless of placement or location. A powerful fan pulls cool air in and pushes warm used air up and away. Fandaire's constant gravity tube drainage gives continuous movement to condensate.

With its low, clean-lined silhouette, Fandaire does not detract from the general architectural effect of the building. And weighing ⅓ less than conventional installations, the Fandaire usually can be positioned where needed, without guy wires or extra bracing. Savings in piping and installation alone may be considerable.

Where there is a problem of architectural compatibility, or of cost or performance, chances are the new Fandaire Air-Cooled Condenser is the best solution. Engineered in sizes from 3 to 120 tons per unit, there is a Fandaire model for practically all single or multiple installations. Get complete information today.

YUBA

specialists in circular air-cooled condensers

YUBA-AIMCO DIVISION
801 West 21st Street, Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Cleveland • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

Here's How KENNEDY'S Design and Construction Features Give You Greater Value for Your Valve Dollar...

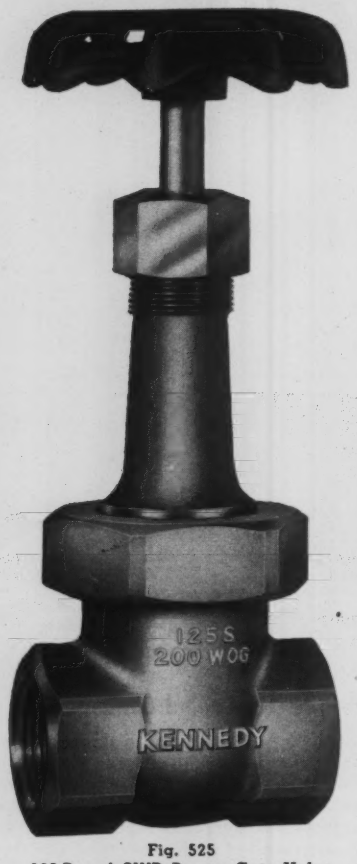
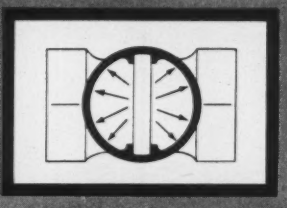


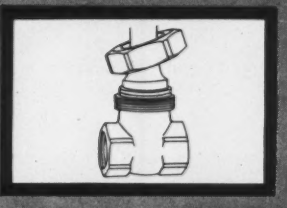
Fig. 525
125-Pound SWP Bronze Gate Valve
Union Bonnet - Rising Stem
Inside Screw - Wedge Disc

KENALLOY Stem . . . standard with Kennedy! is strongly inhibited against dezincification and corrosion. It is a long-wearing metal for longer easier operation.

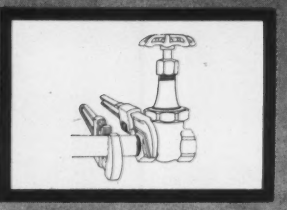
Cylindrical Body withstands sudden pressure. Kennedy's Cylindrical Body construction resists rupture and minimizes deflection when under severe pressure.



Heavy Bronze Union Bonnet Ring is entirely separate from the bonnet to eliminate any possibility of springing the bonnet face when assembling or disassembling the valve for cleaning or inspection.



The Kennedy wider hex ends are blended into body making the body and hexes one unit. This rugged construction prevents distortion and wrench pressure is absorbed.



These additional advantages make KENNEDY your best valve buy . . .

Fig. 525 . . . newest in the valve field . . . best in the valve field. Fig. 525 gives greater strength with less bulk and weight than any comparably rated valve.

Kennedy's Fig. 525 can be repacked under pressure thus eliminating line shut-down. Simply open valve fully, remove packing nut and repack.

Threads in the KENALLOY Stem are accurately machined to eliminate feather edge ends which in ordinary valve stems break off and lock the stem in the bonnet. This accurate machining means easier operation and longer valve life.

The joint between the body and the bonnet is bronze-to-bronze true union. Generally accepted as the most satisfactory type of union joint.

• YOU CAN'T BUY A BETTER VALVE THEN A KENNEDY!

KENNEDY VALVE MFG. CO.
ELMIRA, NEW YORK
VALVES • PIPE FITTINGS • FIRE HYDRANTS

• OFFICES AND WAREHOUSES IN NEW YORK, CHICAGO, SEATTLE, SAN FRANCISCO, ATLANTA • SALES REPRESENTATIVES IN PRINCIPAL CITIES •

You can use this new Foxboro pneumatic transmitter on six different process measurements

pressure – temperature – liquid level – differential pressure – dew point – flow... all six with guaranteed accuracy of ±½ of 1%

Think of it . . . a universal pneumatic transmitter with matched elements for six different process variables. That's the new Foxboro M/45 pneumatic indicating transmitter.

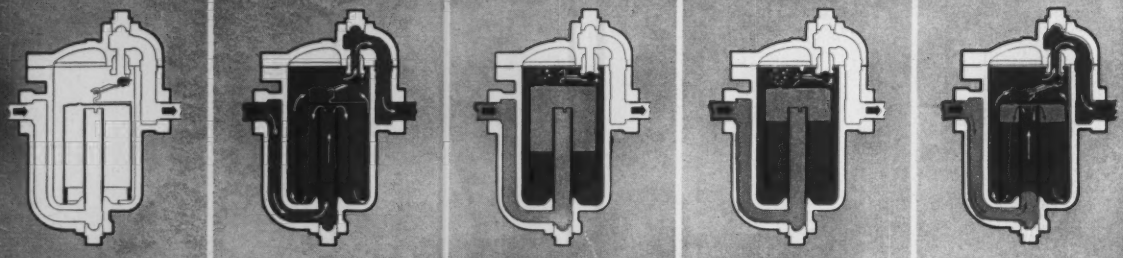
And with the M/45 you get: *universal* high accuracy-guaranteed at ±½ of 1%; *universal* ambient temperature stability — less than ½ of 1% in 50°F temperature change; *universal* calibration and simplicity of servicing. A remarkable combination of versatility and uniformity in a single instrument.

The new Foxboro M/45 indicating transmitter can extend the benefits of standardization throughout your whole plant operation. Ask your Foxboro field engineer to tell you about it. Or write for Bulletin 13-30. The Foxboro Company, 966 Neponset Ave., Foxboro, Mass.

FOXBORO

REG. U. S. PAT. OFF.

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

● Amstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* – Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* – Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* – Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service. 800 Series, side inlet, side outlet. No. 801, side inlet, bottom outlet. 880 Series, integral strainer. 200 Series, bottom inlet, top outlet. Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8943 Maple Street ● Three Rivers, Michigan

"See Our Catalog in Sweet's Plant Engineering File"

and they run
and they run
and they run

1903—
Indianapolis.
a trolley car.
a rolling adventure surrounded by noise.
pennies, nickels, children . . .

and inside—
a Fairbanks Morse electric motor.
it drove the trolley over thousands of miles
and rode with it
into glorious retirement.

pick a year—
from the turn of the century until now.
pick a month,
pick a day,
pick a city,
pick a town—
our motors are in its history . . .
pulsing, driving, working.
powering the things we need
and the things we want.
pushing our daily advances.
pulling us into the future.

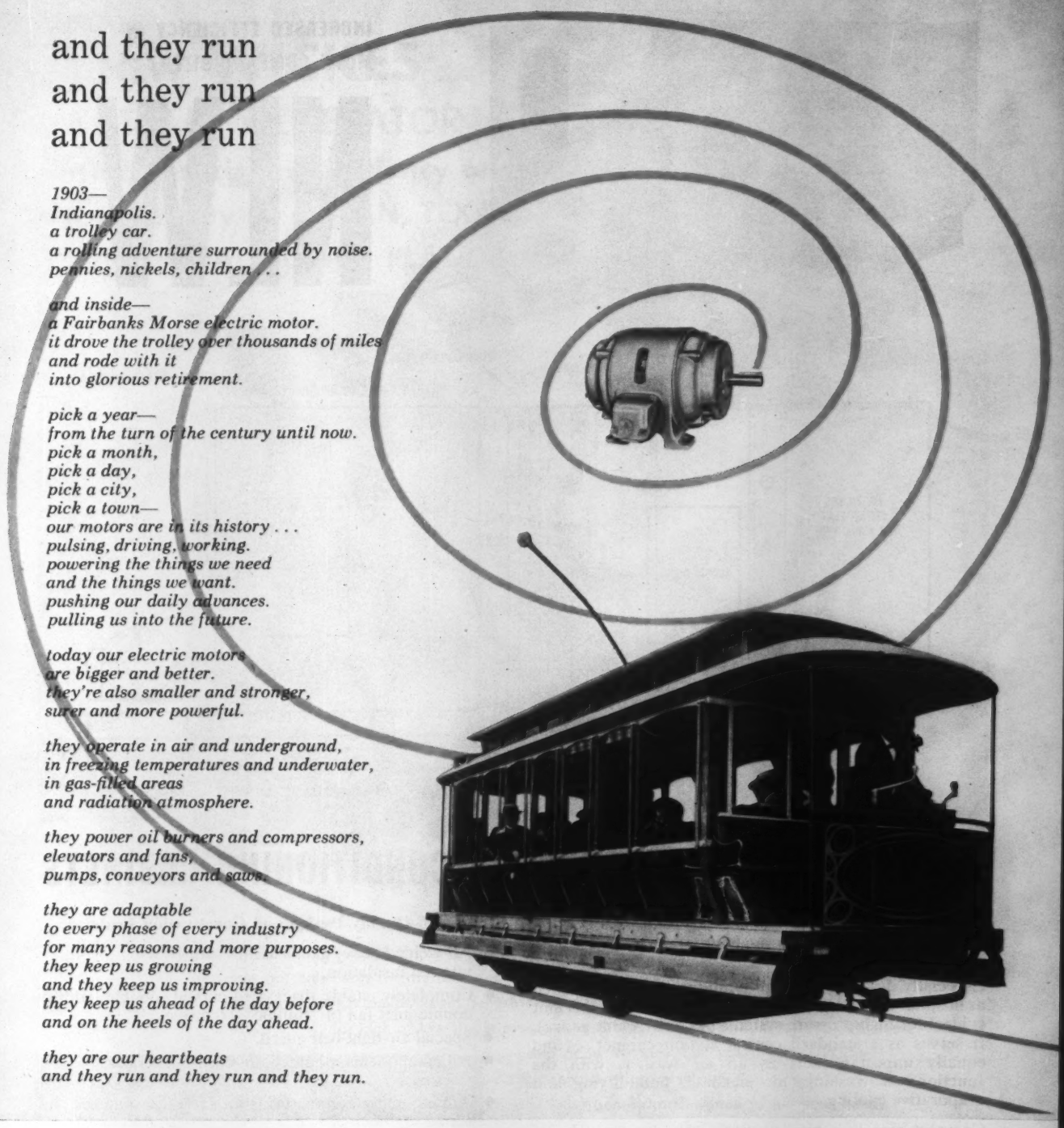
today our electric motors
are bigger and better.
they're also smaller and stronger,
surer and more powerful.

they operate in air and underground,
in freezing temperatures and underwater,
in gas-filled areas
and radiation atmosphere.

they power oil burners and compressors,
elevators and fans,
pumps, conveyors and saws.

they are adaptable
to every phase of every industry
for many reasons and more purposes.
they keep us growing
and they keep us improving.
they keep us ahead of the day before
and on the heels of the day ahead.

they are our heartbeats
and they run and they run and they run.

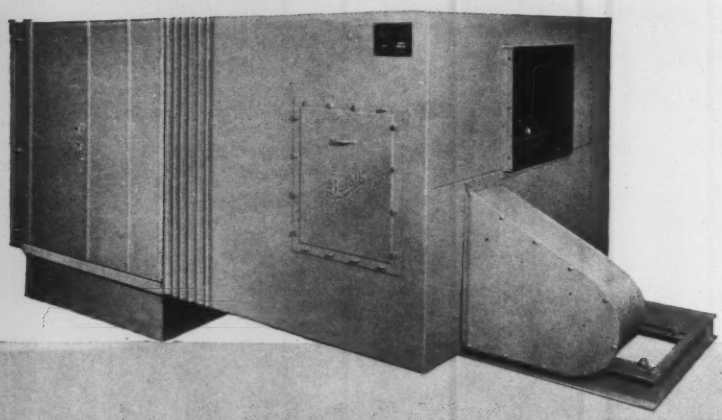


Fairbanks, Morse

A MAJOR INDUSTRIAL COMPONENT OF **FAIRBANKS WHITNEY CORPORATION**

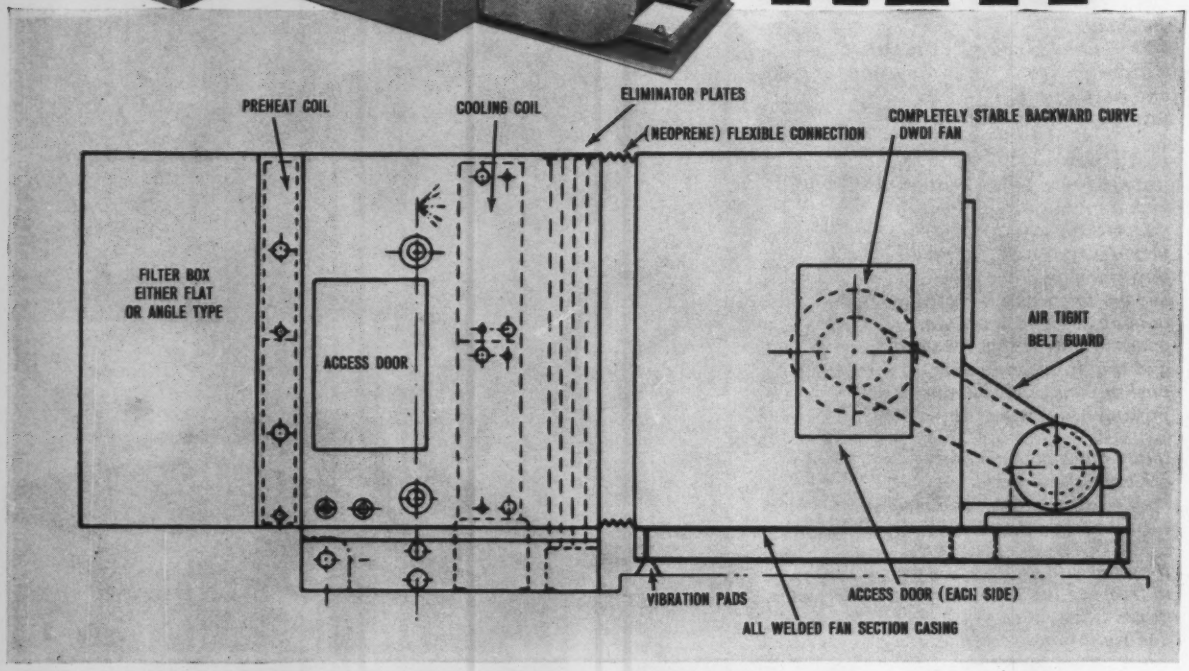
The electric motor is one of the most versatile sources of power ever developed. It is economical, practical and time-resistant. Fairbanks-Morse electric motors can turn out ½ horsepower or 10,000 horsepower, meet every known job demand within this range or be custom-specified to your blue-print projections. Whatever your production needs or plans may be, our electric motors can power them.

If you are in a field where power for production must be efficient, effective and dependable—we suggest that you consider our great variety of electric motors. For further information please write to: Mr. George H. Herrick, Vice President and General Manager, Electrical Division, Fairbanks, Morse & Co., Freeport, Illinois.



INCREASED EFFICIENCY IN
MORE COMPACT SIZE

NEW



"BUFFALO" HIGH PRESSURE AIR CONDITIONING CABINETS

- **A Complete Package — Buffalo "Q" Factor Construction throughout.**

Especially designed for high humidity installations such as hospital operating rooms and laboratories . . . this unit is ideal for high pressure systems (4″ to 8″ water gauge). It serves as a standard central station cabinet . . . and equally important acts as an air washer, with the functions of washing, air cleaning, humidifying and evaporative cooling.

Compact size is a big advantage. Unique new design reduces cabinet, ducts and grills. Evaporative cooling by recirculated spray water minimizes operation of mechanical refrigeration equipment during marginal weather.

"Buffalo" Quality Design and Construction Features:

- All-welded heavy gauge casing with 1″ internal insulation.
- Completely stable backward-curved double width, double inlet fan (a "Buffalo" exclusive).
- Special air-tight belt guard.
- All components mounted on sturdy structural steel base.
- Among many accessories is an exclusive matched sound attenuator.

It's easy to get complete facts on these new High Pressure Air Conditioning Cabinets. Call your "Buffalo" Engineering Representative. Or write direct for Bulletin AC-150.

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Buffalo Pumps Division, Buffalo, N. Y.

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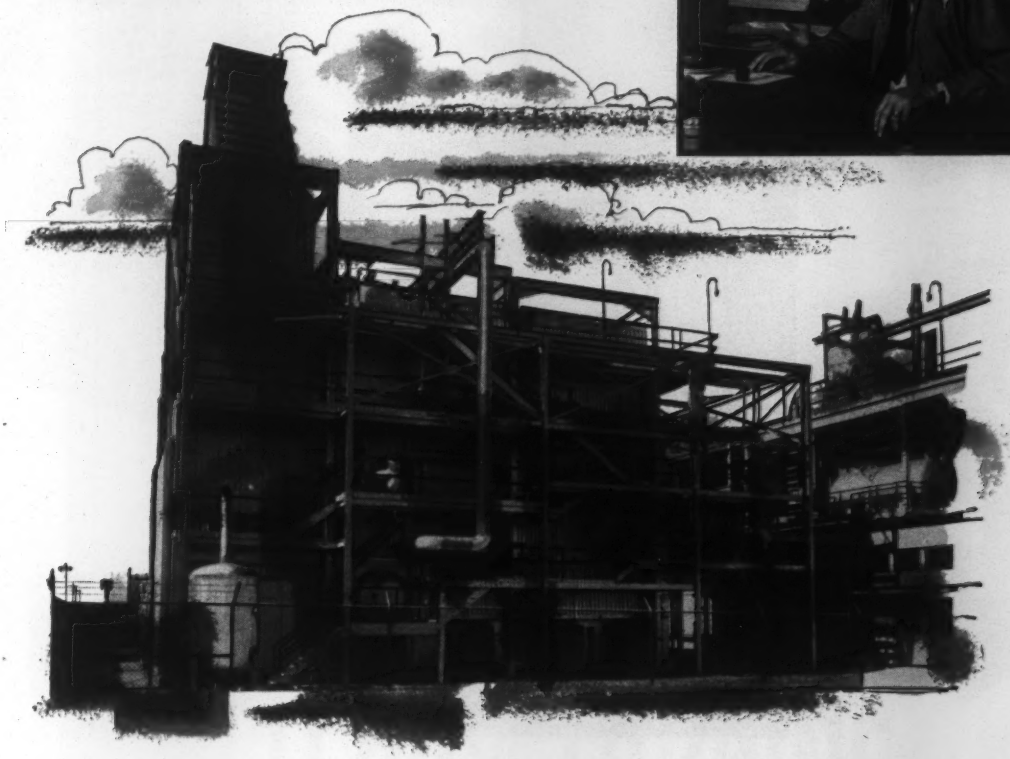
NEW WICKES STEAM GENERATOR

insures maximum efficiency and dependability for BRYAN, TEXAS, MUNICIPAL POWER PLANT

Calvin W. Beard, Superintendent of the Electric Utilities of Bryan, Texas, Municipal System: "As in every other power plant, our steam generator must give completely dependable performance day in and day out".



This Wickes Type RB 2 drum boiler is designed to produce 220,000 lbs. of steam per hour at 875 psig and 900° total steam temperature for the city of Bryan, Texas. The unit performs not only with remarkable dependability, but with Wickes' usual efficiency and economy. Wickes Boiler Co. builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods. See your nearest Wickes representative for full information on a Wickes steam generator designed to suit your needs.

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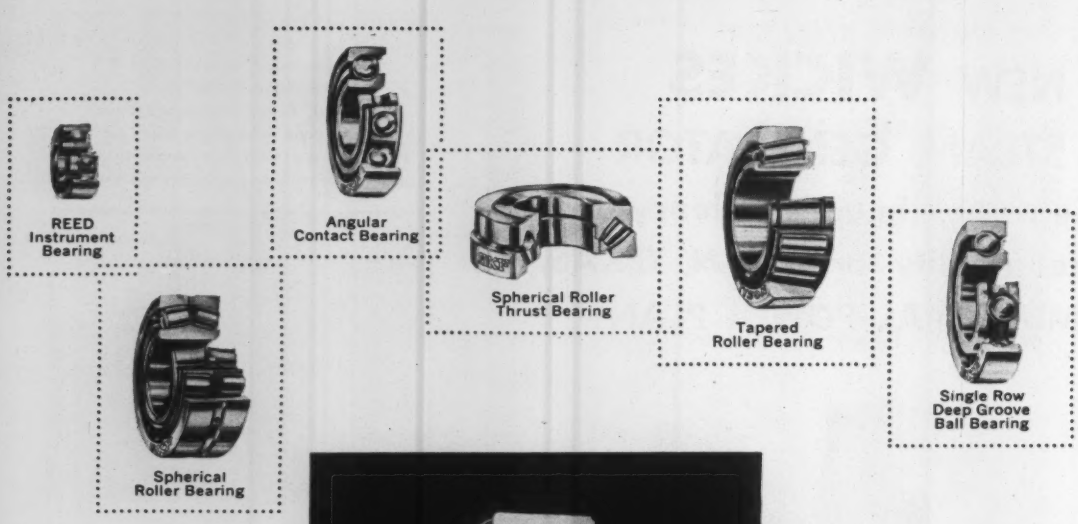
Bulletin 55-1 gives details of a wide variety of designs and sizes of Wickes field-erected and shop-assembled steam generators. Write for your free copy.

174

WICKES BOILER CO., SAGINAW 13, MICHIGAN, DIVISION OF THE WICKES CORPORATION

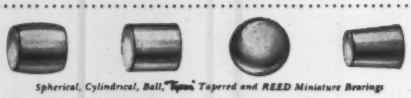


What's a "special size" in production bearings?

SKF makes so many standard sizes, there's practically no such thing as a "special size" of bearing. They range from tiny instrument bearings right up to four-row tapered roller bearings—and account for almost every possible bore size in-between.

Take SKF's standard cylindrical roller bearing, for example. It's promptly available in 154 sizes of single- and double-row types—for shaft diameters ranging from 1" to 9.5". Every size, in both types, offers high radial capacity in relation to its size and operates at highest speeds because of its very low friction.

So, before you specify a "special size" bearing, call the nearest SKF sales office first. The odds are better than 1,000 to 1 that there's already a standard SKF bearing of exactly the size you need. 6007



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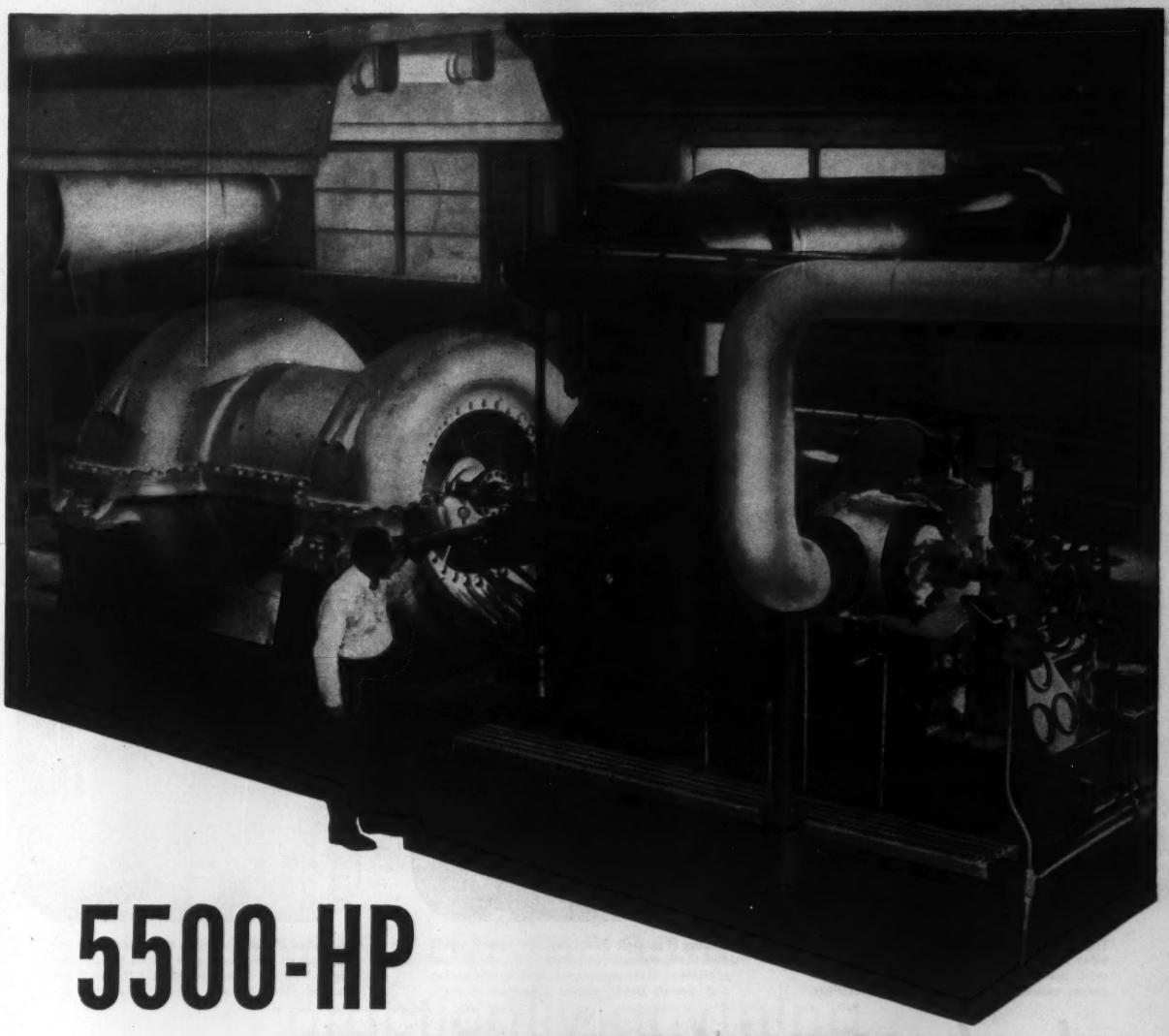

5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

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TERRY SQUARE, HARTFORD 1, CONN.

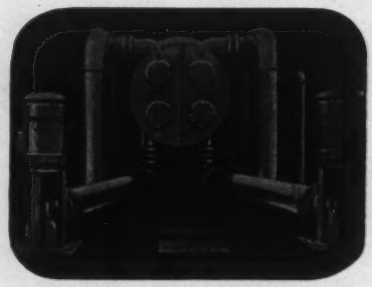
TT-1215

and auxiliary equipment

HOW C.H. WHEELER CONDENSER DESIGN saves space...

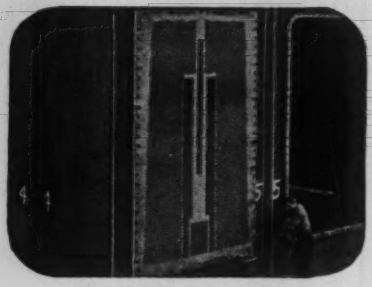
Head Room problems are solved by compact condensers like this one. Turbine floor to basement floor, in this case, is only 20 ft. The Unit has 65,000 square feet of condensing surface.

Rectangular Cross Section makes C.H. Wheeler Condensers adaptable to nearly any space or condenser arrangement because the length, width and height of any Wheeler Unit can be varied almost at will.

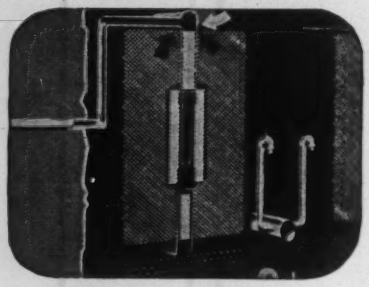


But Wheeler Doesn't limit itself to rectangular design. A round cross section worked out better here, for example, at the first planned gas-steam turbine station ever designed and built in United States.

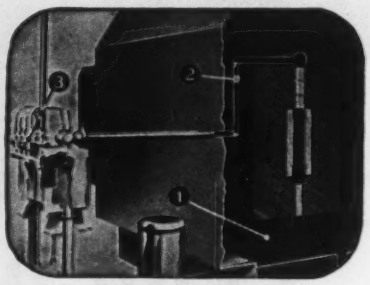
improves power generating efficiencies...



Triple Lane tube layout, another design feature, provides 3 pathways for steam travel, utilizes maximum cooling surface and produces higher condenser vacuums for power generating stations.

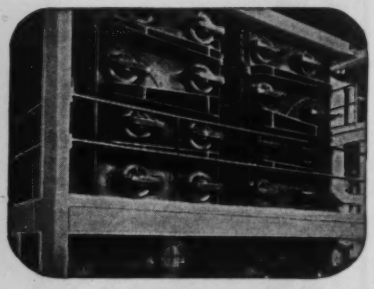


Location of air-vapor takeoff speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.

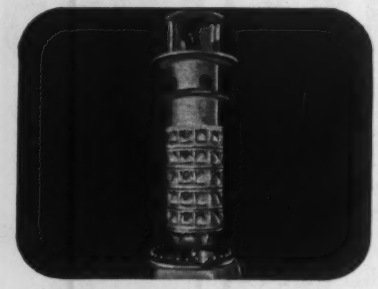


Deaeration of condensate not to exceed 0.01 cc. oxygen/liter is available with special Wheeler designs. Note the Deaerating Bars (1), the Air-Vapor Suction Line (2), and Tubejet® Ejectors (3).

and reduces maintenance



Patented Reverse Flow permits flushing tubes and sheets without shutting down Unit, during full load with either or both circulating pumps operating. No additional circulating water inlet or discharge piping necessary with C.H. Wheeler's Reverse Flow.



"Pull-Out" Condensate Pumps simplify maintenance because entire pumping element, including all rotating parts, can be removed without disturbing either the pump barrel or the piping connections.

C. H. Wheeler Circulating Pumps, like Condensate Pumps, are easy to inspect and maintain because of "Pull-Out" design. In addition, shafts are heat treated alloy steel and impellers are statically and dynamically balanced for trouble-free operation.

C. H. Wheeler has been designing and building condensers since 1903; has developed such features as Dual Bank Design and Reverse Flow.

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Whenever you see the name C. H. Wheeler on a product, you know it's a quality product

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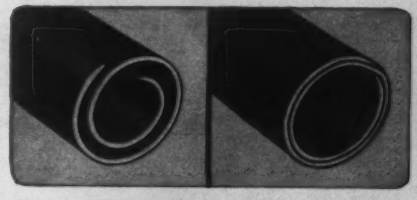
Bundy can mass-fabricate practically anything

...and we use Bundyweld®—the double-walled steel tubing—for parts that must meet rigid specifications

YOUR tubing headaches are Bundy's business. Our tubing engineers will work with you at any stage in the development of your product. With years of problem solving experience, we can often suggest short cuts that cut costs of tubing parts—or find practical solutions to tough bends.

Then we'll mass-fabricate these parts on machines specially designed by Bundy for precision bending. We use Bundyweld, the original double-walled steel tubing, that has become the safety standard in small-diameter tubing. It's thinner walled—yet stronger, has high bursting and fatigue strengths. Covered by Government Spec. MIL-T-3520, Type III.

Why don't *you* take advantage of Bundy's complete service: expert engineering help, mass-fabrication savings, *Bundyweld* tubing. For more information see Sweet's Product Design File, 1e/Bu . . . or contact us!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no substitute for the original Bundyweld Tubing.

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size is no problem!

The bigger your tubular steel problem – the better we like it! Why? Because with all our modern facilities "under one roof," we are completely equipped to handle a variety of difficult jobs – expertly and economically! For expert consultation on centrifugally spun tube applications in your field... call on ACIPCO.

VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

SIZE RANGE: Lengths up to 40 feet to meet modern machinery requirements have been produced. O.D.'s from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

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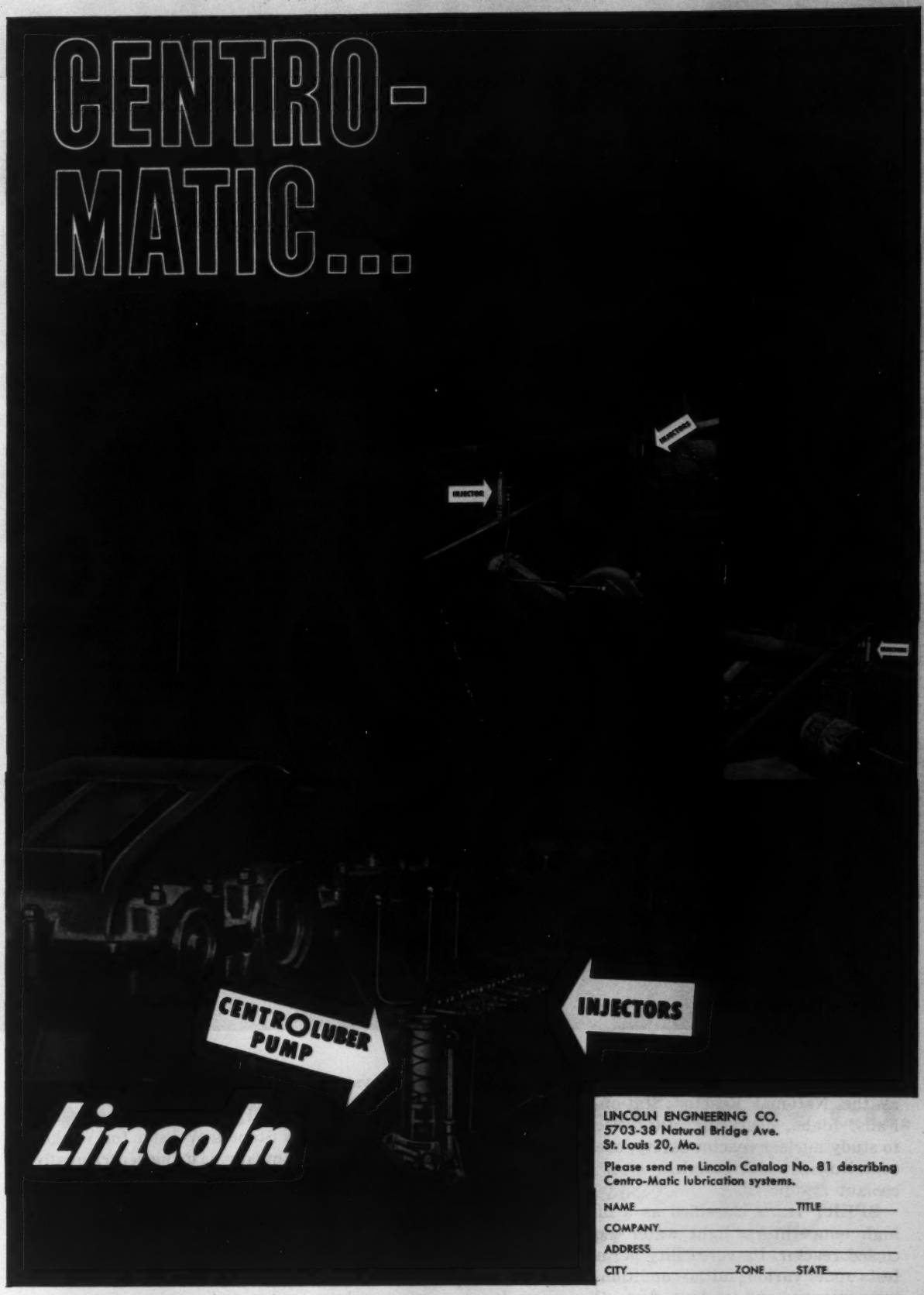

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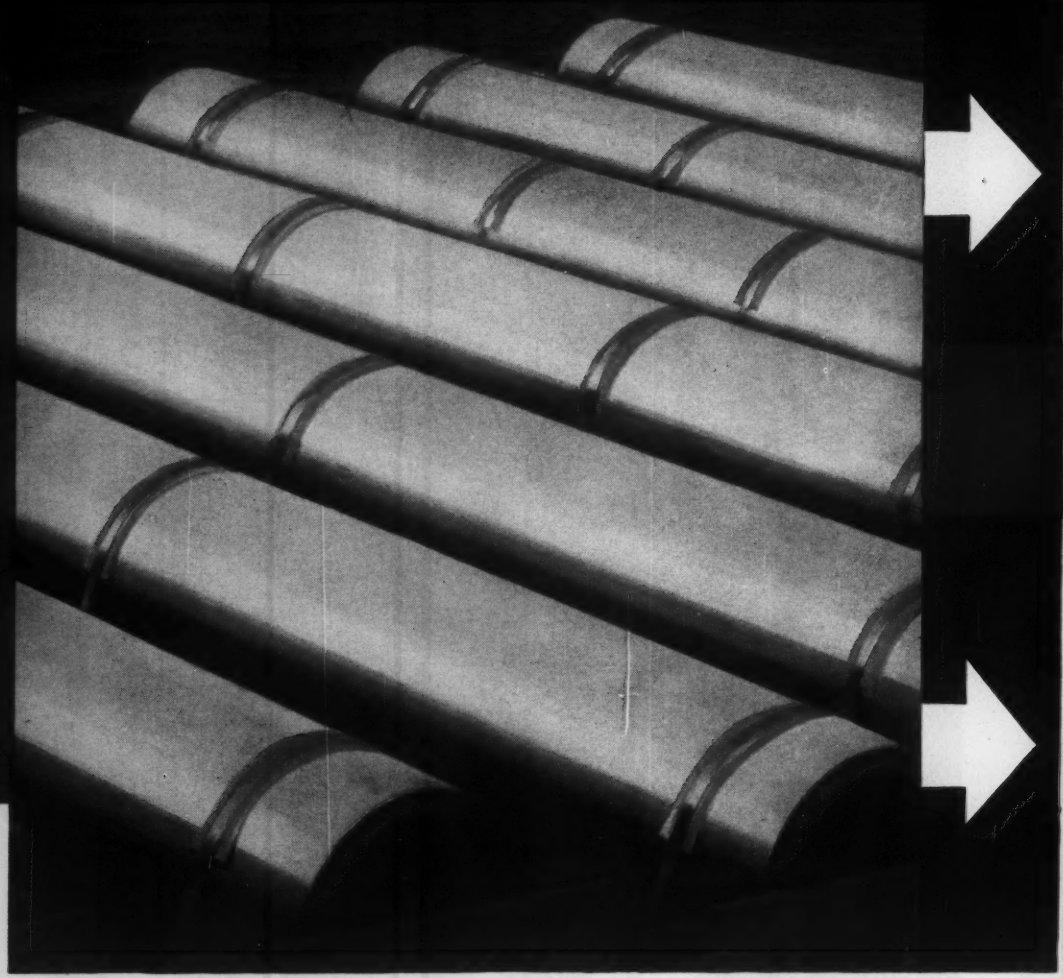


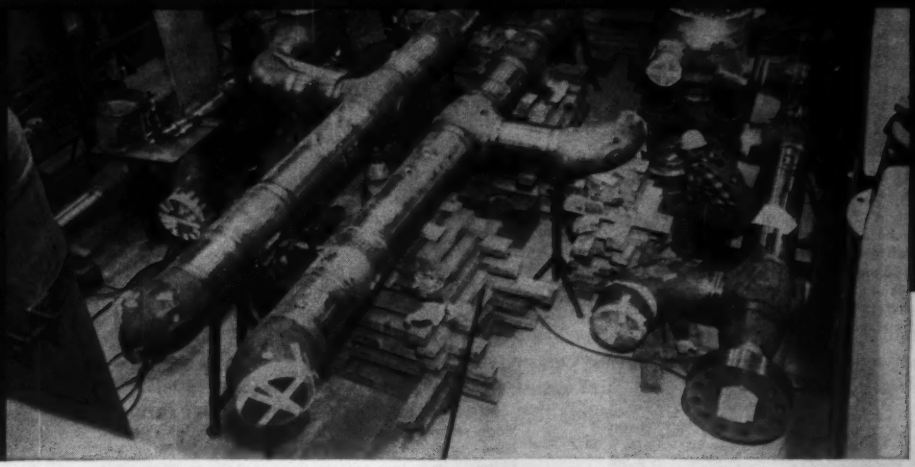
The Government's new SPERT III nuclear plant at the National Reactor Station near Idaho Falls, Idaho, operating since December, 1958 to study nuclear reactor safety, uses U.S. Pipe's centrifugally cast stainless steel pipe for its coolant system.

SPERT III is classified as a high pressure, high temperature, light water moderated and cooled reactor. Its versatility permits transient tests under various initial conditions of pressure, temperature, and coolant flow. For example, pressures ranging from atmospheric to 2,500 psi and water temperatures from 68° to 668° F.

Another new nuclear power plant, engineered and constructed by Stone & Webster for Yankee Atomic Electric Company, is using centrifugally cast stainless steel heat exchanger shells made by U.S. Pipe and fabricated by the Southwestern Engineering Company in Los Angeles, Calif.

Stainless steel, centrifugally cast, made to rigid specifications, may be the answer to your piping or heat exchanger problem. For more information, write or call:

centrifugally cast stainless



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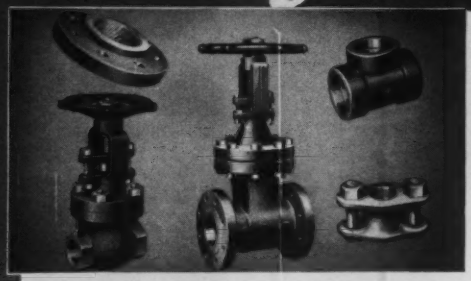
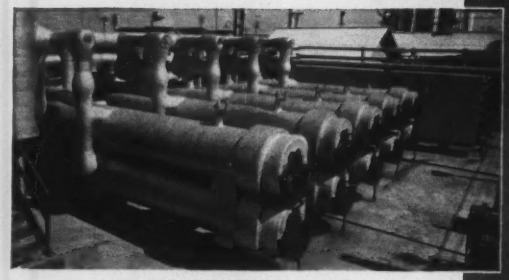
Designed for today's Tough service demands



FORGED STEEL VALVES & FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

Forged from carbon and alloy steels, Vogt valves, fittings, flanges and unions are built to safely handle liquids and gases at high pressures and temperatures in the modern petroleum refinery and petro-chemical plants. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and weld caps.

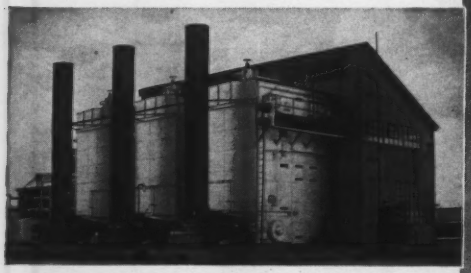


PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.

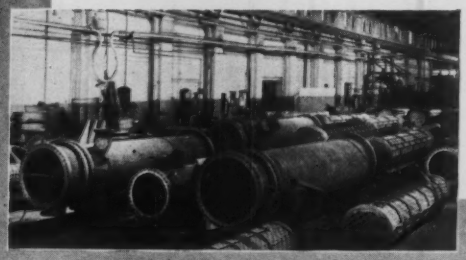
MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Compression Systems and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants and institutions here and abroad.



HIGH EFFICIENCY STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube and straight tube designs are available for solid, liquid or gaseous fuels to meet every power, process or heating requirement.



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Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.

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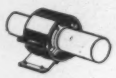

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Wherever there's pipe movement . . . thermal growth . . . vibration . . . there's a Flexonics product to absorb, guide, or control it.

Flexonics Corrugated Expansion Joints are expertly engineered to your needs, hydraulically formed, metallurgically treated by exclusive techniques, for maximum cyclic life. **Flexonics Expansion Compensators** offer the lowest-cost way, inch for inch, to absorb thermal growth in pipes or tubing 3" and smaller. **Flexonics Flexible Connectors** absorb vibration, permit random movement in pipes up to 24". **Flexonics Pipe Alignment Guides** and Roller Pipe Supports provide better guiding than old-fashioned methods, yet they cost less. **Check and mail the coupon today.**

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ROTARY OR CENTRIFUGAL

...Which one is best for your application?

Rotary or centrifugal? Sometimes the choice is easy. For example, you would use a rotary pump for very viscous liquids (over 2500 s.s.u.). Or where poor suction conditions exist. Or when positive displacement is required. Centrifugal pumps would be used for extremely corrosive or abrasive liquids, low viscosity liquids (under 2500 s.s.u.) water, slurries, or petroleum products.

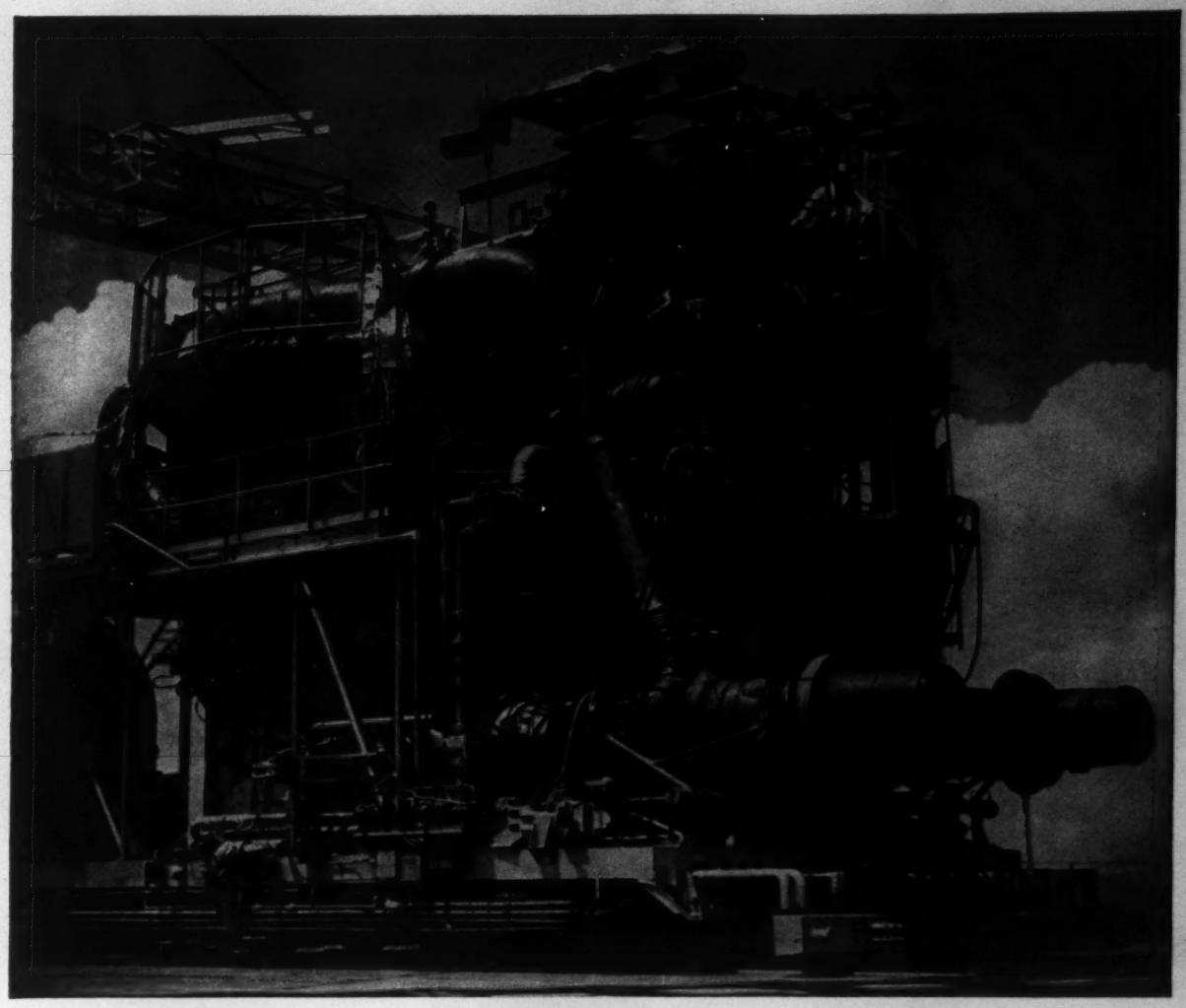
But . . . in many applications combinations of these factors exist. Or the liquid you want to pump is not clearly in either area. Then there are other considerations such as initial cost, operating cost, lubrication value of the liquid, location and even budget limitations.

All of these considerations can put you in the middle—where either a rotary or centrifugal can be used. The best choice can only be made by someone with experience and knowledge of both types.

As one of the few manufacturers of a complete line of both rotary and centrifugal pumps, Worthington can help you select the best, most economical solution to this perennial pump problem. For the name and address of your nearest Worthington representative, consult the yellow pages.

P.S. If you'd like a copy of a 50-page booklet, "Rotary and Centrifugal Pumps: Theory and Design," please write to Worthington Corporation, Section 20-14, Harrison, New Jersey, for bulletin G-2666.

WORTHINGTON



Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

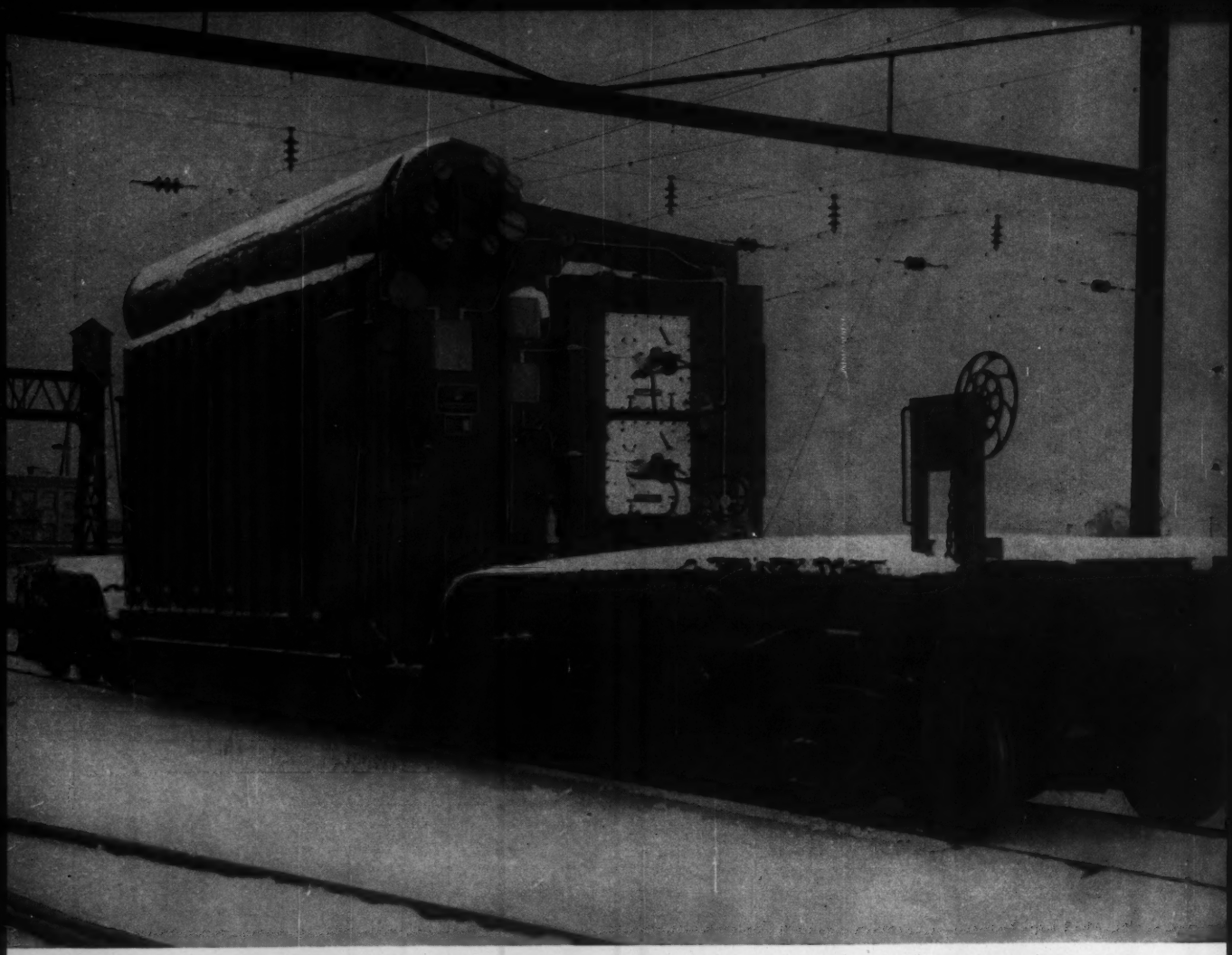
This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS



Special purpose application...a standard steam package

This Foster Wheeler packaged steam generator is standard in virtually every respect except for its unusually high design pressure. The AGX-series unit shown here will deliver over 65,000 lb of steam per hr to test high pressure steam turbines at DeLaval Steam Turbine Company, Trenton, N. J. The Foster Wheeler AGX-series packaged units are designed to operate at pressures from 901 to 1,350 psi.

Don't let out-of-the-ordinary steam requirements keep you from considering the economy and convenience of a packaged steam generator installation. The proven basic design of standard Foster Wheeler steam generators allows you wide latitude for adapting to special needs.

Look at the features you have to work with. High steam purity, generous furnace volume, highly efficient convection tube bank, liberal drum size, removable drum internals, to name only a few. All necessary standard equipment is included.

There's no better or more complete packaged steam generator design available today at a comparable cost. Write for FW bulletin PG-58-2 *before* you write specifications for *any* steam generator from 13,000 to 100,000 lb/hr capacity at pressures from 270 to 1,350 psi. Foster Wheeler Corporation, 666 Fifth Ave., New York 19, N. Y.

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

MECHANICAL ENGINEERING

VOLUME 82 • NUMBER 6 • JUNE, 1960

Nuclear Milestone

Another milestone in the use of nuclear energy for peaceful purposes has been achieved by United States engineers.

In northern Illinois, homes, farms, offices, and factories are now receiving electricity from the first full-scale, privately financed all-nuclear power plant in the world: Commonwealth Edison Company's 180,000-kw, Dresden Nuclear Power Station. The General Electric Company designed and constructed the plant which is located eight miles east of Morris, Ill. Bechtel Corporation is the engineer-constructor.

Start-up of the Dresden plant also marks initial electric production from the largest nuclear power reactor in service or under construction in this country.

Its first power was generated when steam was produced in its huge boiling-water reactor and turned a 180,000-kw turbine generator. The reactor is a light-water moderated, dual-cycle, heterogeneous type. Its fuel is UO_2.

First output from the plant reached 64,000 kw, but the production rate was stepped up gradually with testing done at various levels.

In the dual-cycle reactor, energy is removed from the reactor core directly by steam which flows to the primary turbine control valves and indirectly by extracting heat through a heat exchanger from the reactor recirculating water to produce steam at a lower pressure. The lower-pressure steam flows to the turbine through the secondary turbine control valves. The primary and secondary steam passes through a conventional turbine cycle with a condenser, feed pumps, and extraction feedwater heaters and then is returned to the primary steam drum and the secondary steam generators. Pressure in the reactor is held constant by the primary turbine control valves. The fraction of the total energy removed through the secondary or low-pressure system controls the temperature of the water returning to the reactor, which, in turn, determines the reactor output.

A brief summary of the over-all plant performance at rated load follows: Gross generator output, 192,000 kw; net station electrical output, 180,000 kw; reactor power output, 626,000 kw; net plant heat rate, 11,880 Btu/kwhr; reactor pressure, 1015 psia; secondary steam generator pressure, 510 psia; turbine back pressure, $2^1/_2$ in. Hg abs; feedwater temperature, 405 F.

Dresden achieved its first atomic chain reaction on Oct. 15, 1959, when the first 28 uranium fuel assemblies were installed in the reactor core. Since then, testing operations have been conducted as the core was loaded to the present 448 fuel assemblies for the initial stage of operation.

Under provisions of the U. S. Atomic Energy Commission start-up license, the Dresden reactor will be brought up to half-power. It will then be shut down to check performance data. After AEC authorization it will be brought up in gradual steps to full power.

By this summer, Dresden will be in full operation—about three years after construction work was begun. Estimated cost: $51 million.

At full capacity of 180,000 kw, Dresden will produce enough electricity to service a city of 200,000 people.

Thus, with the operation of Dresden, the atomic power industry has taken another giant step into the future. But the atom, tiny as it is, can be an expensive item. Let's hope that all the engineering effort—and funds—being poured into the nuclear industry will prove to be rewarding.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

"Control" means to "check, test, or verify; to exercise restraining or directing influence." Management finds research and engineering susceptible to control techniques.

how to CONTROL Research and Engineering

By S. R. Irish[1]

Olin Mathieson Chemical Corporation, East Alton, Ill.

A CONTROL is simply a standard of comparison or a means of verification. In developing a control, we must have a clear assignment which we can later measure as to progress and accomplishment.

Three Parameters of Control

Controls are most effective when they are relatively simple and are tailored to meet the particular type of task or assignment. In some cases more than one control is necessary to have the whole story since there are at least three parameters for most assignments; namely, time, cost, and result. Sometimes all are of equal importance while certain conditions might make one all-important or of no significance at all. The manager must decide and transmit the necessary instruction.

It is fundamental that a control can be developed for almost anything that can be defined. As management of research and engineering is delegated down through an organization, each such spreading of responsibility should actually be dividing the complex problems into understandable parts. If this is true, then we ought to be able to tailor a control to fit this simple assignment for any or all of the elements of time, cost, or result.

A control does not have to be a lengthy report nor a fancy chart. In many cases it may be a verbal check on the phone or a visual check by an inspection trip. These must be recorded, however, in such a manner as will enable a report to be made at the appropriate time to the next higher level. In passing this information upward, there should generally be less and less detail until it reaches the top with something on the order of the Navy's succinct report, "mission accomplished." The equally important "well done," if deserved, should start down the ladder and be expanded as it goes to appropriate commendation to those who deserve it and only to those who have earned it.

Responding to a Trend

There is no real validity to the use of controls if all they do is tell you that someone did or did not complete his delegated assignment. The real value comes from the forces that are put in motion by those responsible just

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Contributed by the Management Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 14–18, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 59—SA-45.

as soon as they see that the trend is not as planned and forecast. It is surprising how rapidly all levels react to such effective controls in taking the action necessary and thereby eliminating the need to explain to superiors why they are off the beam. It is not hard to understand how this relieves the managers of constantly putting out little fires and digging into causes of failure long after the reasons are obscure and unidentifiable. Instead, it gives time to assist when there are real problems that are upsetting the plan, as well as time to plan ahead for new and more important problems.

The story of the development and design of a new automatic operating product of ours will be as effective as anything as a sample of tailored controls on this type of work. We were not sure we could develop the apparatus as desired by sales, and we were quite sure it would be expensive in relation to the potential sales volume.

Division Into Phases

The project was divided into five phases. Estimates of cost and time required were made for the first four phases and presented to management for decision. The first phase was to make preliminary layouts and models of parts to determine certain possibilities requiring about 4 months and 9 per cent of the cost. The second phase was to lay out the complete design in 7 months and 28 per cent of the cost.

The third phase called for the detailing of all parts, requiring 7 months and about 28 per cent of cost. The fourth phase was to build an experimental model estimated to require 4 to 6 months to work out bugs and costing about 35 per cent of the original estimate. The fifth phase covering patterns, jigs, fixtures, and tools necessary for production runs was left unestimated until after the design had been completed and approved.

When management approved, an order covering the first phase was issued authorizing expenditure of the amount estimated and a schedule set up for the parts which were to be tested in preliminary design. A check was made at the board with the project engineer at least weekly as to results accomplished. Each month, accounting-department figures showed the amount of actual expenditures compared with the project engineer's estimate in per cent.

This work was completed within three months although the order was left open for several more months to cover any checking that might be required. The final cost was only 60 per cent of the estimate. The order for Phase 2 was then written and the original estimate used for cost. Agreement was reached between the project engineer, engineering superintendent, and plant manager on the schedule and assignments, and frequent checks were made by these three as to actual accomplishments.

Again the accounting records were used to check the project engineer's estimate of expenditures. A simple report on approximately a 2-month basis was made to higher management. Phase 2 was completed in six months and at 40 per cent of the estimate.

Before issuing the order for Phase 3, a review of the estimate was made because of the underruns on the first two phases. It was decided we had had extremely good fortune in some of our selection of design and that the detailing portion would not show the same trend. A reasonably complete schedule of detailing was assigned and the same type of simple controls utilized. The result was that the work was completed 2 months under the original estimate and at 75 per cent of the estimated cost.

Revising the Estimate

At this point a new estimate was made for Phase 4 to cover the cost of the experimental model based on the actual design. This resulted in a substantial reduction in the estimate, but the over-all time was not reduced. This information was transmitted as a report to management with actual costs of the other phases so that a review of the decision could be made before further expenditures were made. There was no change of decision, and the go-ahead was given. A schedule was made as to the completion of each part and for the assembly. Weekly checks were made as to status and on man-hours expended compared to estimate. The model was completed on time and practically at 100 per cent of revised estimate even after the necessary rework of several parts that failed too soon on the endurance test.

With the satisfactory product designed, a careful estimate was made for Phase 5—the tooling to manufacture the product. Again a report was sent to management covering progress and cost to date and estimates of tooling cost and unit cost of production. The necessary approvals were then issued to add the product to the line and application made for the necessary patents.

With approval for expenditure of necessary funds for tooling, a complete layout was made for each part with the number of jigs and fixtures and patterns specified, estimated, and timed. Weekly checks showed the progress of actual results and proportion of time used. Monthly comparison with accounting records double-checked the cost data. The final results were almost 100 per cent as to cost and time, and production started as scheduled.

Corrective Action—in Time

While work was being carried out on each of these phases, we found from our checks or controls that we were departing from schedule, usually on the time element in that other projects had been allowed to interfere. At times we had to assign others to carry out certain details that would get the project back to schedule. These actions were taken soon enough so that checks at the higher levels showed satisfactory accomplishment.

It may be said that the estimates were all too high and that it was no accomplishment to meet them. However, as design progressed and revised estimates were made, the results were much closer to 100 per cent. It is apparent that the preliminary was on the safe side and the final cost less than management had used in their considerations.

It should be noted that there were several points at which a reversal could be made, if desired. If our original estimate had not been sufficient, these reviews would have been more important and would give management a chance to say "we have spent enough, let's call a halt to this project." The real significance seems to be that some controls were used and that, as the project progressed out of the inventive and creative stages, the controls become more definitive and consequently more exact.

Note that the controls are only aids and that action has to be taken if progress or cost is not as planned. The good manager has to understand the use of the controls and what they mean and then has to put the understanding of the problem and the personnel and the equipment into the type of action necessary to obtain the objective.

GAS TURBINE PROPULSION for HYDROFOIL BOATS

Gas turbines made possible a major breakthrough in hydrofoil boat design. "Free power" and "two-spool" units may become the basic power plants for future craft.

By Kenneth A. Austin Chief, Marine and Industrial Sales, Gas Turbine Department, Lycoming Division, Avco Corporation, Stratford, Conn.

ALTHOUGH early aircraft builders experimented with hydrofoil craft and the Wright brothers "flew" a hydrofoil boat at Dayton before they mastered the air at Kitty Hawk, the realization of their true worth has waited for improvements in structural efficiency, power plants, and hydrodynamics. These areas of research are closely related to aircraft practice, and indeed the performance of modern hydrofoil boats owes much to this well-endowed source.

The public concept of marine travel as that of quiet unobtrusive power is well satisfied by the natural smooth ride which the hydrofoil craft provide.

There is a parallel between aircraft and hydrofoil craft in the similarity of the natural critical conditions of sonic flight in air and completely cavitating operation in water. The respective change-over speeds for air and water are approximately 650 and 65 knots, a ratio of 10:1 for a density ratio of 800:1. For both mediums it can be proved that economical operation is possible beyond these speeds, but in such a case a consolidation of experience at high subcritical speeds is most desirable.

The main factor that allowed the efficient design of 100-ton Mach 0.9 aircraft was the use of the gas-turbine engine. As reported here, the same type of power plant has shown similar advantages in hydrofoil boats. It is clear that gas turbines offer a decisive breakthrough in hydrofoil vessel design, and that henceforth turbine-driven boats of 20 to 200 tons displacements can expect to offer new standards in speed, comfort, and economy.

Contributed by the Gas Turbine Power Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 59—A-324.

Power Plant and Transmission Requirements

Although hydrofoil vehicles are almost as weight and power-conscious as aircraft, the power plant and transmission system have seldom been detailed in the literature. Since the merits of different foil systems are still the subject of vigorous debate, an engine manufacturer may be excused for being as neutral as possible.

The typical power and speed requirements for these craft are compared in Fig. 1 with those for round-bilge and hard-chine boats. Once past the low-speed drag, which is higher up to the take-off "hump," the speed achieved for a given power is much better than that for

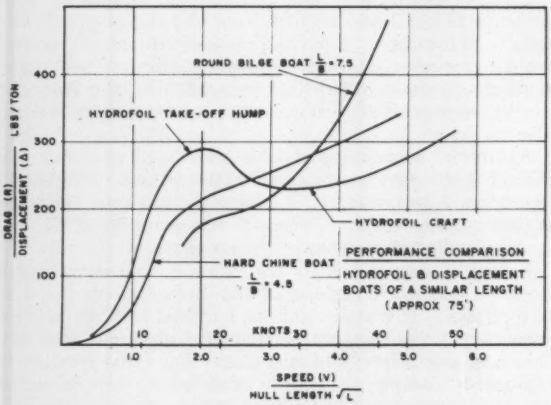

Fig. 1 Power and speed requirements

conventional boats. The take-off should be as short as possible to avoid wave pounding and should occur at a $V/\sqrt{L}$ of less than 3.0. The power pattern, therefore, is one of short-duration maximum take-off power followed by a sustained 75 to 85 per cent power cruise. Low power is normally used solely for harbor maneuvering.

The examples of successfully demonstrated hydrofoil-craft propulsion arrangements [1, 2, and 5],[1] are of two basic types; (*a*) Surface-piercing foils—where, for a given lift, the immersed area changes with speed; (*b*) fully submerged foils—where the immersed area is constant and a given lift is proportional to speed and foil incidence.

The layout varies considerably, with no distinctive trend evident for either foil system. As to propulsion through air or water, since this paper is deliberately limited to subcavitating craft with speeds up to 65 knots, the case for an air propeller is considered a minor item.

Air Propulsion. The normal use of directly coupled podded engines, avoiding the obvious complications of long underwater drives, and a specific transmission weight of about 0.30 lb per hp—less than half that of the simplest water-propeller system [3]—make air propulsion mechanically attractive. Below 50 knots, however, efficiency is normally less than for a water propeller. Although special high-activity propellers or compact ducted fans of 4.0 to 6.0-lb thrust per hp can be designed, the associated awkward above-decks arrangements and noise are undesirable. The public concept of marine travel is of quiet, unobtrusive power, and air propulsion, in the author's opinion, is bound to lose favor to a quieter mechanism. Relative difficulties are of no concern to a fare-paying passenger. He will support the most pleasant ride.

Water Propulsion. ***Power Plant and Layout.*** Power for subcavitating hydrofoil boats, Table 1, calls for the installation of approximately 50 to 80-hp per ton displacement in as light and compact a package as possible, in a layout mainly influenced by the foil transmission system.

To date, the bulk of experience has been achieved on lightweight diesel engines of about 6.0 lb per hp bare specific weight. As at least 25 per cent more must be added for cooling equipment and other accessories, this means that the machinery weight has been between 18 and 30 per cent of the gross weight of the boat. Some experimental boats, such as the *Bras d'Or* [4] and the Grumman XCH-4 [7] have increased their performance by using the better specific weight of aircraft piston engines (about 2.5 lb per hp installed). By comparison, the machinery weight of a four-engine piston aircraft weighing 60 tons and carrying 75 passengers is about 8 tons or 13 per cent of the gross weight.

[1] Numbers in brackets designate References at end of paper.

The percentage of boat weight on each foil varies according to the system used, but in general the center of gravity of the boat is normally about half the over-all length from the bow. This means that the larger, higher-powered boats have to use a central-engine-room arrangement, a less desirable location than toward the stern.

Air cooling of the engines is preferred because of the additional drag and annoying complications required to scoop up water when the boat is in the "flying" position.

Transmission. Hydrofoil boats require the water propeller to be placed much further below the hull than is usual with a displacement boat, requiring a greater shaft angle, a longer prop shaft, or a bevel-gear drive mechanism.

The experimental LCVP *Halobetes*, Figs. 2, 3, 11, obviously called for a retractable foil and transmission system for beaching operations, but the modest draft of other craft and normal operation in navigable waters of good depth enable a fixed system to be used. The latter, however, has upper limits in the larger boat sizes. The added sea-state hull clearance required may mean that special-purpose boats and those above 100 tons will need a retractable transmission system [3].

The propeller must satisfy the conflicting demands of high thrust at low speed for a fast take-off and good efficiency when flying for an economical high cruising speed. Normal operation at high speed is usually the controlling factor and great care is taken to provide as clean an entry for the propeller-water inflow as possible. Long fixed systems such as the *Supramar* PT-10 and PT-20 use thin transmission shafts with a propeller mounted ahead of the final steady bearing to reduce interference to a minimum. Other boats such as *Halobetes*, *Bras d'Or*, and the *Flying DUKW*, Figs. 4–7, that use gear drives have the propellers mounted on slim, streamlined nacelles. The latter two use tractor propellers operating in undisturbed water to achieve the best efficiency.

There is a clear case for the use of a variable-pitch propeller in hydrofoil boats, particularly when bevel drive systems are used and the nacelle cross section provides sufficient area to mask the necessary hub diameter to accommodate the pitch-change mechanism. In addition to improving take-off and cruise performance, the variable-pitch propeller would eliminate the need and weight of an ahead and astern transmission.

Turbine Advantages

Configuration. Free-power turbines or two-spool engines are the most suitable of various possible configurations. Single-shaft turbines are almost entirely limited to air-propeller-driven designs. The free-power turbine is simpler and better proved than the two-spool engine,

Table 1 Hydrofoil Craft—Design Specification Details

Craft	Foil system	Designer	Length, ft	Displ. Δ, tons	V max, knots	Power, hp	Bhp Δ	Payload, tons	Payload, per cent
VS-6	Surface-piercing hoop	Shertel-Sachsenberg	50.0	17.0	47.0	1400	82.4	3.0	17.7
TS-6	" " "	" "	39.3	6.3	40.0	380	60.2	1.4	22.2
VS-8	" " "	" "	105.0	80.0	43.0	4000	50.0	26.0	32.5
PT-10	" " "	Supramar	47.0	9.2	47.0	550	59.8	2.6	28.2
PT-20	" " "	"	68.0	28.0	43.0	1350	48.2	6.8	24.3
PT-50	" " "	"	88.6	50.0	43.0	2700	54.0	14.2	28.4
XCH-4	Surface-piercing ladder	Grumman	53.0	8.0	75.0	1260	157.0		
Sea Legs	Fully submerged incidence control	Gibbs & Cox	29.0	5.0	30.0	200	40.0		
Highpockets	Surface-piercing hoop	Baker	24.0	5.8	36.0	125	44.7		
Bras D'Or	Surface-piercing ladder	Saunders-Roe	59.0	20.0	55.0	3000	150.0	3.5	17.5
Halobetes	Fully submerged incidence control	Miami S. C.	40.0	15.0	36.0	825	55.0	4.0	26.6
Flying DUKW	" " " "	Lycoming-Avco	32.0	13.0	27.0+	860	66.2		
Aquastroll	Fully submerged planing support	Aquavion	47.1	16.7	38.0	500	30.0	3.24	19.4

GAS TURBINE PROPULSION for HYDROFOIL BOATS

HALOBETES

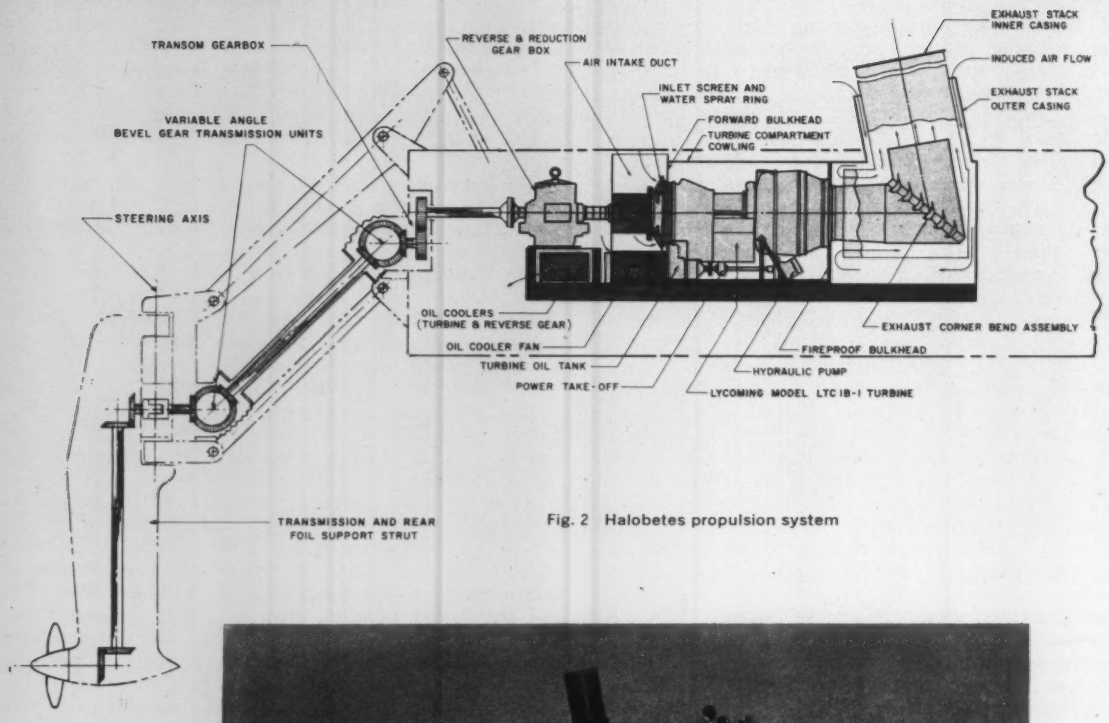

Fig. 2 Halobetes propulsion system

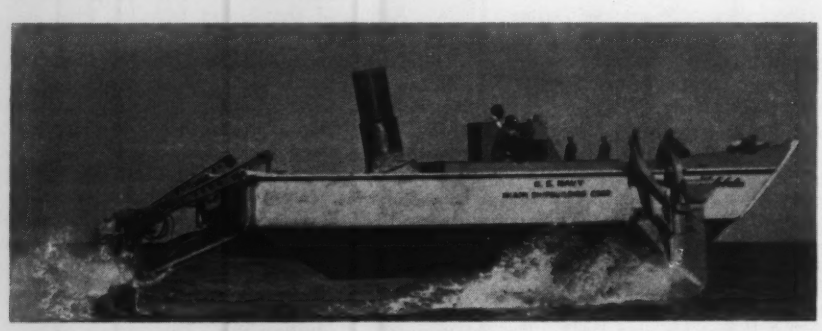

Fig. 3 Halobetes flight trials

Halobetes. The 15-ton, 40-ft landing craft, LCVP Halobetes, with a 4-ton cargo space, was first powered by a 630-hp gasoline engine. This was replaced with a custom-packaged Lycoming T53-L-1 shaft turbine [6] complete with air inlet, exhaust ducting, and oil-cooling system assembled onto a common base with a new light-weight transmission unit. The instrument panels and their connecting looms were also prefabricated. The boat had a fully submerged incidence-controlled retractable-foil system. The front two foils were mounted on thin struts and the rear one on the lower end of the over-stern transmission unit. Not only was the over-stern unit retractable in flight, but it could be pivoted 20 deg to port and starboard for steering purposes.

The power drive came from the marine ahead and astern gearbox at a maximum power speed of 2100 rpm into a 2:1 step-up gearbox bolted into the transom. The gear-box output, speeded up to decrease the torque, was applied through the two sets of bevel gears into a constant-velocity joint positioned with its neutral axis in line with the steering pivots. Once into the transmission strut, the power was taken normally through two bevel gear meshes to the propeller shaft. Total weight of the over-stern unit was approximately 3750 lb.

A self-contained oil system cooled by the water flow was used. Engine air flow at 7000 cfm was taken in through a false bulkhead in the rear of the cargo compartment using the engine room as a plenum chamber. A double-walled and cooled exhaust system was both compatible (not more than 150 F) with the wooden construction and discharged at a safe level for personnel on deck. The gas-turbine installation saved about 2000 lb or 6.5 per cent of design gross weight. Maximum speed—36 knots—was about the same for the gasoline engine and the turbine, although the take-off performance was much improved by the high torque developed by the free-power turbine at low-output shaft speeds.

FLYING DUKW

▲ Fig. 4 DUKW turbine power package

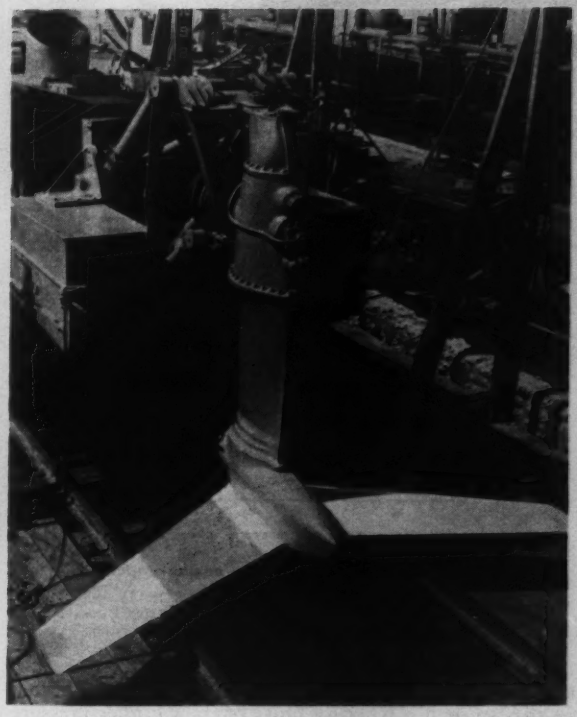

Fig. 5 DUKW overstern unit ▶

Flying DUKW. The U. S. Army Flying DUKW is a conventional amphibious vehicle converted to hydrofoil operation to increase its range and speed (see MECHANICAL ENGINEERING, October, 1959, p. 86). A self-contained, 1400-lb Lycoming T53-L-1 turbine power package was installed and the normal vaporizing system of the combustion was qualified to operate on up to No. 3 diesel oil. Although the engine room served as a plenum chamber, as it did in Halobetes, power loss from oil-cooler heat was kept to 3½ per cent (Halobetes, 7½ per cent) by ducting the warm air into the turbine-exhaust eductor system.

A hydraulically operated disk brake replaced the marine gearbox or clutch system providing an alternative "neutral" and controlling the movement of the boat during engine starts. The over-stern transmission assembly was adequately rated at 1000 hp for a propeller speed of 1600 rpm. Though similar in gear-train layout, a 34-in-diam, 24-in-pitch tractor propeller was used to achieve the cleanest water in-flow and best possible efficiency.

Operation of the propulsion system has been excellent with a high degree of reliability. Because of the wheels and other design features, there is greater drag at take-off than for Halobetes. At an average 26,000 lb AUW (All-Up Weight) the vehicle takes off at about 12 knots and has achieved speeds in excess of 27 knots. The characteristics of power required from take-off to maximum speed have proved very similar to those of Halobetes. Noise, though slightly higher in the crew compartment than Halobetes, has been quite satisfactory. The same relative quietness of the vehicle at moderate distances has been noticed.

▲ Fig. 6 DUKW taxiing trials

▼Fig. 7 DUKW flying trials

GAS TURBINE PROPULSION for HYDROFOIL BOATS

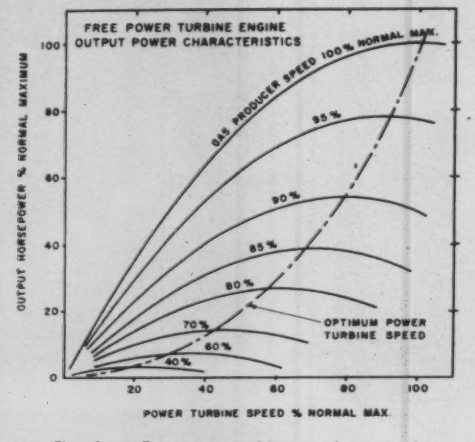

Fig. 8 Free-power-turbine engine-output power characteristics

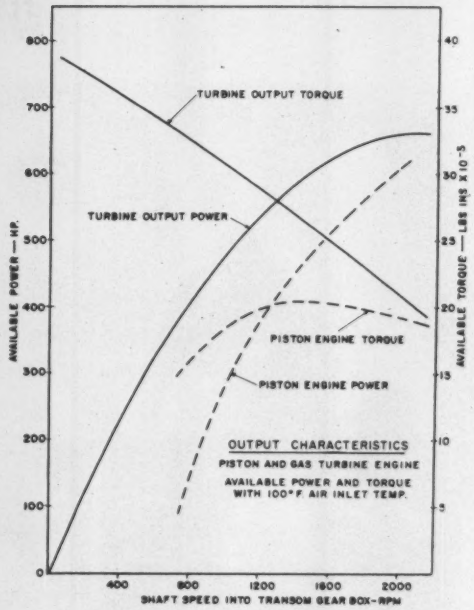
TURBINE OUTPUT TORQUE
TURBINE OUTPUT POWER
PISTON ENGINE TORQUE
PISTON ENGINE POWER
OUTPUT CHARACTERISTICS
PISTON AND GAS TURBINE ENGINE
AVAILABLE POWER AND TORQUE
WITH 100° F. AIR INLET TEMP.
AVAILABLE POWER — HP.
AVAILABLE TORQUE — LBS INS X 10⁻⁵
SHAFT SPEED INTO TRANSOM GEAR BOX-RPM

Fig. 9 Comparison of output power and torque characteristics of piston and gas turbine engines

although the two-spool engine with the load connected to the l-p or h-p rotating units offers a higher pressure ratio and better fuel economy. Though in use in the newer aircraft and heavier industrial power plants, it has yet to be applied to surface transportation. It seems likely that it will become the basic design of the second generation of turbine engines for hydrofoil boats.

Power Characteristics. The point of maximum power for the free-power turbine, Fig. 8, with respect to output speed, for an increasing range of gas-producer speeds is approximately an x^3 function. In other words, it closely matches the "prop-law" power requirement of a fixed-pitch propeller. If a variable-pitch propeller is considered, the fan of unique blade angle, power-absorption plots can be accommodated within the wide power spread.

Part-load fuel consumption of a turbine—that is, below 50 per cent load—is relatively unimportant with a hydrofoil boat since, as with an aircraft, over 90 per cent of boat operations are high-speed cruise at 70 to 85 per cent of maximum power.

With a free-power turbine, if the turbine is loaded up while maintaining the gas-producer speed constant, the output torque will rise and finally reach a fully stalled torque value of about twice that developed at maximum power. This characteristic, Fig. 9, is markedly different from that of a piston engine and allows a high torque to be given to the propeller at low speed. The improvement in thrust gives a fast acceleration to the boat and a quick take-off, an effect that is valuable to a hydrofoil boat in rough seas.

Weight and Space. When comparing weight and power of current gas turbines and turbocharged diesel engines, the diesels are generally light-weight, high-speed machines. Many more different large turbines, above 2000 hp, have been built than large diesels. Development time and cost seem to be in favor of the turbine and increase with size. Even the robust, long-life marine turbines have many times better specific weights than the most highly turbocharged diesels.

Two further groups of engines should be briefly considered. Diesel-turbine compound engines can and have been built that are lower in weight per hp than heavy-duty turbines, but in the opinion of the author these engines, though creditable, represent extreme machinery design. They are costly to develop and deficient in reliability compared with what can be expected of present, let alone future, turbines. A type of gas turbine that should emerge in the near future will have an excellent maximum-power specific fuel consumption of about 0.40 lb per hp per hr, and will maintain this economy down into a low part-load range.

Turbines are smaller than the bare diesel engines by a factor of two or three, although air and exhaust ducting for the turbine can reduce some of this advantage. However, there is much less heat loss and less plumbing for a turbine. Turbocharged diesels need cooling equipment capable of removing 25.0 to 35.0 Btu per hp per min. A turbine requires cooling equipment for 1.0 to 3.0 Btu per hp per min.

Hydrofoil Craft Performance

An analysis of relative performance of a hydrofoil boat with turbines instead of piston power depends tremendously on the design chosen for comparison. One based on a series of boats using 60 hp per ton for a cruising speed of 50 knots is shown in Fig. 10. It considers conservative turbine weights and turbine specific fuel consumptions ranging from 0.65 to 0.55 lb per hp per hr as the

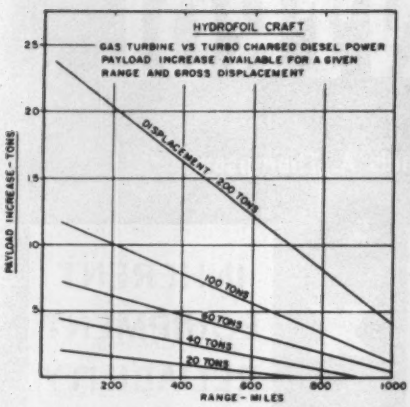

Fig. 10 Payload increase made possible through turbine power

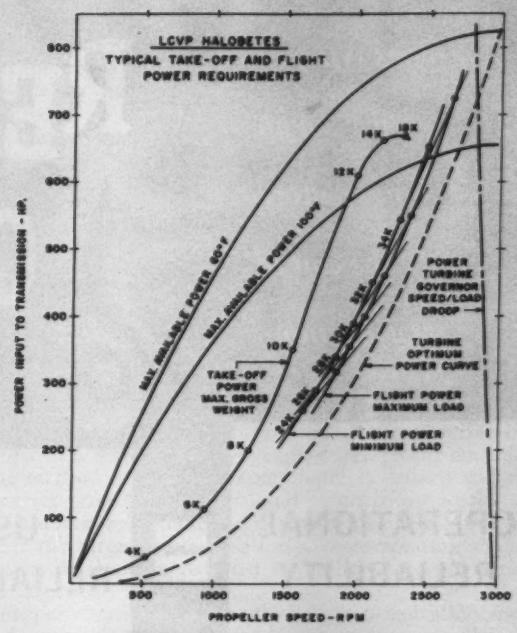
LCVP HALOBETES
TYPICAL TAKE-OFF AND FLIGHT
POWER REQUIREMENTS
POWER INPUT TO TRANSMISSION - HP.
PROPELLER SPEED - RPM
MAX. AVAILABLE POWER 60%
MAX. AVAILABLE POWER 100%
TAKE-OFF POWER MAX. GROSS WEIGHT
POWER TURBINE GOVERNOR SPEED/LOAD DROOP
TURBINE OPTIMUM POWER CURVE
FLIGHT POWER MAXIMUM LOAD
FLIGHT POWER MINIMUM LOAD

Fig. 11 Halobetes power requirements. Once the craft had taken off and was past the "hump," power could be reduced 50 per cent and the boat still flew.

power requirement increased. No secondary weight-saving advantages in favor of the turbine were taken into account.

The plot shows large gains in payload for all displacements out to beyond a 600-mile range. Taking 250-mile range and existing hulls as as example, an average 30 per cent payload increase is shown to be obtainable with turbine power. The greater fuel cost is easily covered by the larger payload revenue or a lower operation "break-even" factor.

This analysis is conservative. It is based on current hull, foil-system, and engine designs and does not reflect the further efficiency that could be obtained by maintaining the original payload and redesigning for a smaller boat and less power to carry it.

Summary and Future Prospects

Successful operation of hydrofoil craft, both as to economic commercial transportation and military advantage using boats similar to the 130-passenger *Supramar* PT 50, pictured at the begining of this article, has been amply demonstrated. New commercial routes may be expected to open up, and larger and more sophisticated military craft will also appear.

The excellent performance of the lightweight diesel will be increasingly challenged by new generations of gas-turbine engines. For many designs, these are the only possible choice. In particular, the inherent propeller-power speed-matching characteristic of the free-power turbine has been demonstrated, together with the remarkable improvement that natural high-torque conversion of this engine can make to take-off distances and time.

Much remains to be done, particularly in simple retractable transmission and foil systems, but the future of the gas turbine as the propulsion unit is quite clear. Passenger appeal, following turbine-aircraft experience, may be taken for granted and the fully smooth characteristic of turbine power enjoyed as a perfect complement to the one smooth method of marine travel.

Acknowledgments

The author's thanks are due to the Department of the Navy, Bureau of Ships, U. S. Army Ordnance Corps, and the Defence Research Board, Canada, for permission to publish details of their respective hydrofoil projects. Acknowledgment is also due the following companies for permission to give technical data and publish photographs of their designs: Supramar Ltd.; Miami Shipbuilding Corporation; Gibbs & Cox, Inc.; Grumman Aircraft Engineering Corporation; and Cabi-Cattaneo, Milan, Italy. The co-operation of the Design Group personnel on the *Halobetes* and *DUKW* is also appreciated; particularly that of R. J. Johnston, R. J. Hutchinson, and J. Buhler of the Miami Shipbuilding Corporation, and W. O'Connor, L. S. Votre, and G. Billings of Lycoming Division, Avco Corporation.

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In modern weapons systems, we can no longer afford the cost of malfunctions.

RELIABILITY CONTROL

By Francis A. Thompson

OPERATIONAL RELIABILITY = **USE RELIABILITY** × **INHERENT EQUIPMENT RELIABILITY**

Conventional control methods have failed. Government and industry are creating a new discipline.

USE RELIABILITY

- OPERATING & MAINTENANCE PROCEDURES
- OPERATIONAL SUITABILITY (HUMAN ENGINEERING)
- EFFECTS OF MAINTENANCE
- AUXILIARY & SUPPORTING EQUIPMENT
- CAPABILITY OF OPERATING & MAINTENANCE PERSONNEL
- INSTALLATION ENVIRONMENT
- DETERIORATION IN STORAGE
- EFFECTS OF SHIPPING AND HANDLING

INHERENT EQUIPMENT RELIABILITY

- SELECTION & APPLICATION OF CIRCUITS
- PARTS & TUBES APPLICATION
- COMPONENT OPERATIONAL PARAMETERS
- MECHANICAL STRUCTURES
- MANUFACTURING TECHNIQUES
- WORKMANSHIP

The complexity, cost, and accelerated pace of development of modern weapon systems are presenting a new challenge to the engineering profession. Conventional methods of design by "trial and error" are proving inadequate. Because of the great effectiveness of modern weapon systems, the quantities produced are relatively small. The cost of initial development prohibits even those changes which appear to be necessary as a result of the first service trials.

All this adds up to the fact that these complex weapon systems must be designed right the first time! If a weapon system is not properly designed initially, it is no longer possible to experiment and keep changing it until it works—both time and money prevent it. The trend is to drop such projects and cancel the contract. All pertinent knowledge, experience, and resources must be co-ordinated in order to bring them to bear effectively and economically on every single design decision. Reliability is emerging as a new engineering science.

Although much has been done to develop a scientific approach to reliability, the surface barely has been scratched. Among the greatest problems are methods of testing as well as interpretation and evaluation of test results. For example, the lack of standard methods for the interpretation of vibration data and other telemetered information has hampered many programs. Often reliability demonstrations require too much time and are much too expensive. Methods of accelerated testing need much more study, attention, and co-ordination to relieve these problems.

Symposiums and Committees

National attention was first focused on the reliability problem at a symposium on Electronic Problems of Guided Missiles held early in 1952 and initiated by the Guided Missile Guidance Section, Electronics Division of the Bureau of Aeronautics. A session on reliability had more attendees than any of the other sessions. It was there that the seed was sown which stimulated the military and their contractors into undertaking organized reliability action.

Until recently, most so-called "reliability" efforts were concerned almost exclusively with electronic equipment, but the recent third Navy-Industry Conference on Aeronautical Reliability covered a wide range of mechanical and structural problems. The conference is now sponsored by the Chief of the Bureau of Naval Weapons.[2] Increasing the reliability and readiness of first-line weapon systems has become a problem of the highest priority in the Navy.

The first national conference with important sessions on reliability, not held under the auspices of the military, was the Joint Electronic Components Symposium sponsored by the Institute of Radio Engineers and the American Institute of Electrical Engineers in May, 1954.

All three military departments have established vigorous reliability programs, and the Office of the Director of Defense Research and Engineering in the Department of Defense is closely watching all developments in the field. Committees have been formed for each specific problem in the area of reliability.

[1] Assistant for Reliability Techniques, Avionics Division, Bureau of Aeronautics, U. S. Navy, Washington, D. C.

[2] On December 1, 1959, the Bureau of Aeronautics and the Bureau of Ordnance merged to form the Bureau of Naval Weapons.

Contributed by the Aviation Division and presented at the Annual Meeting, November 29–December 4, 1959, of The American Society of Mechanical Engineers. Condensed from Paper No. 59—A-326.

General Principles

A number of principles and concepts have evolved from these symposiums and committees as a joint effort of government and industry. These concepts are applicable to all aeronautical material, not just electronics. Reliability has emerged as another performance characteristic, as a new design parameter that should be specified contractually and measured for compliance.

It is recognized that conventional engineering and production methods will not produce modern weapons of adequate reliability. The Office of the Secretary of Defense and the three Military Departments regard the reliability problem as large enough to warrant a specialized direct attack. Reliability objectives or quantitative requirements should be included in contracts. Reliability control is a start-to-finish operation and must be administered by a qualified group at a responsible level.

The Bureau of Naval Weapons currently is engaged in an interesting experiment which includes an incentive clause for the attainment of a quantitative reliability target in a major weapon-system development contract. The method for proof of compliance is defined and the contract provides for additional profit in proportion to the amount by which the demonstrated reliability exceeds the target value, and for a corresponding money penalty if the demonstrated reliability does not attain the target.

Proper consideration should be given and allowances made relative to the importance factor, complexity, effectiveness, state-of-the-art, and similar matters. Acceptance criteria for subsystems can be stated in terms of "mean time between failures," MTBF, which should be either demonstrated under specified conditions in the laboratory or computed from the results of appropriate tests of constituent components. Guarantee of follow-up action may be required once the complete system has become operational.

Unfortunately, MTBF is a statistical concept and its use can cause misunderstanding if its implications are not thoroughly understood. The use of an unrealistic MTBF requirement may place the contractor who knows the most about the problem in an unfavorable position for he will in all probability indicate that the requirement is unrealistic. However, this is no different from bid requests for proposals to meet other performance requirements.

Many contracts require progress reports at stated intervals, such as monthly or quarterly, and special reports at specified monitoring points during the design, development, prototype, service test, pilot production, and production. These reports should include a periodic assessment of reliability during all stages of the system life cycle, and serve as the basis for the development of reliability growth or monitoring curves. Reports should not confine themselves to achievements, but should also consider deficiency areas, indicating both the problem and the contractor's plan for solving it, since the customer may have information which may be of help to the contractor.

Closely allied to the reliability requirement is the maintenance characteristic of the system. The maintenance of modern complex weapon systems requires a number of personnel with very special skills. It is necessary to recruit and start the training early in the weapon-system development if such personnel are to be available in the proper numbers when the first weapon-

system deliveries are made. Reasonably accurate estimates are necessary on the number of maintenance personnel and the respective skill levels required to maintain the proposed system even before the first prototype is completed.

Reliability-Control Techniques

Every basic operation in the design, manufacture, and operation of a weapon system has some influence on its reliability. Yet at the present state-of-the-art it is extremely difficult to demonstrate reliability either analytically or in a statistically valid manner at all levels of development.

The most important area where the reliability engineer provides specialized support is in aiding the design department to insure the necessary inherent reliability. There are already a number of standard engineering procedures, such as design reviews, component evaluation, and selection, which must only be intensified or systematized to provide significant contributions to a modern reliability control program. These older techniques alone, however, are no longer adequate to insure the necessary reliability of complex weapon systems, and a number of new or refined procedures are being developed.

The initial reliability effort must start with the development of the original system concept. In fact, its greatest contribution can be made at this point. If the basic system design is deficient at the start, no amount of reliability control in any other area can ever correct or make up for the basic design defects. Reliability cannot be tested into a product! On the other hand, if the basic design is inherently sound and reliable, and some phase of the execution is faulty, something can always be done to salvage the project. The major difficulty in establishing quantitative reliability control of the design phase is to obtain recognition and understanding of the fact that the design phase is susceptible to and will greatly benefit from reliability control.

At this stage it is usually possible in a rough screening process to determine, by comparing one arrangement with another, that certain system configurations are obviously technically inferior to others. When the inferior configurations are eliminated, the designer is left with a small number of competing configurations between which he usually cannot make a selection on an intuitive basis. It is then necessary to determine all of the significant factors which must be considered.

Once all of the significant design parameters are established in quantitative terms, it becomes possible to compare competing features on a competitive basis and to trade off one feature against another, to arrive at an optimum system.

Another key study insuring high-order inherent reliability in modern complex systems is the analysis of the interaction effects of connecting systems or nearby installed systems; the compatibility of interrelated components, blackboxes, and subsystems; and the effects of the installation environment.

In certain mechanical systems, especially power-operated flight-control systems, present specifications call for thorough dynamic analysis and demonstration. In addition, the Bureau of Aeronautics has developed a unique requirement for the preparation of the so-called failure or failure-effect analysis of all aircraft flight-control systems. This requires that all critical components (or functions) of the system be identified and that each one in turn be assumed to fail in the most adverse position and/or condition. For each assumed failure the following must be considered: (*a*) The consequence of the failure; (*b*) the compensating provisions in the system; (*c*) the reliability of the critical component. A similar analysis is used with gas-turbine controls.

Cost Savings

By the use of reliability-control procedures and by maintaining the tightest control over production, it has been possible to eliminate all postfactory testing and maintenance. The Bullpup is the first missile to be treated as a round of ammunition—once it leaves the factory, there are no tests and no maintenance; it is simply mounted on a launcher and fired. The elimination of test equipment in this case resulted in substantial savings, estimated for the first year's outfitting as:

Missile test equipment	$3,000,000
Test-equipment facilities	1,000,000
Training and personnel support	1,000,000
Spares	1,767,000
Total saving	$6,767,000

Co-operation Between Engineers

There is an increasing need for co-operation between different branches of engineering, especially mechanical and electronic design engineers. The technical advances in electronics in the past decade have been so rapid and breathtaking that it has required a man's complete attention and energy to keep up with his specialty.

Electronic equipment has become big and heavy, approaching a ton in some airborne equipments. These are subject to extreme environments, such as shocks and accelerations on aircraft-carrier landings or missile launchings; vibrations due to engines of tremendous power or high speeds; temperatures in Arctic cold, desert heat, or high altitudes; the sandstorms of the desert and the salt-water spray of the carrier deck. Not the least of these extreme environmental conditions are the human limitations of the operators and maintenance men, working in field conditions under the pressure of combat.

These are certainly all problems which present a real challenge for the expert designer of machinery and hardware. The electronic designer needs the mechanical engineer. On the other hand, he has much to offer the mechanical engineer. The electronic engineer has developed a unique systems approach. He has learned to apply operations-research techniques and other highly mathematical models to create order in a situation of appalling complexity. Some of these techniques can be applied with great benefit to mechanical systems. In fact, the mechanical engineer can no longer cope with some complex mechanical systems without adapting some of the techniques originally developed by electronic engineers.

Acknowledgment

The author wishes to express his gratitude to C. M. Beyer, Office of the Director of Guided Missiles, Office of the Secretary of Defense, and to E. J. Nucci, Office of Electronics, Office of the Director of Defense Research and Engineering, Department of Defense, for their interest and assistance in the preparation of this paper.

NOTE: Before condensation, the paper included a Bibliography and a Selected List of Reliability Specifications.

a special report

MAN and his thermal environment

For design of space vehicles, the need for data is obvious. But these studies of man's tolerance to heat and cold are also providing data for down-to-earth man-machine problems of industry.

The Industrial Worker[1]

By Lucien Brouha, P. E. Smith, Jr., and Mary E. Maxfield

For any but very short periods the human body must be in thermal equilibrium with its environment if life is to be maintained.

When the environment is cooler than the body, heat is lost to the environment by radiation, convection and, to a much lesser extent, conduction; but as the environmental temperature rises these methods of heat loss become less and less efficient until finally, when the environmental temperature reaches that of the skin, heat loss through these channels ceases altogether. At still higher environmental temperatures, the thermal gradient is reversed; this gradient reversal may likewise occur in skin areas receiving radiant heat.

The success of the body in its fight against heat depends on its ability to dissipate heat. Physiologically, several important mechanisms are involved, outstanding of which are (*a*) the formation of sweat, and (*b*) the transfer of the excess heat from its site of production to the periphery.

The evaporation of 1 liter of sweat will remove, under good environmental conditions, 600 k cal of heat from the body. This means that a 75-kilo man with a specific heat of 0.8 could lower his body temperature 10 C by evaporating 1 liter of sweat. Hence an individual working at the rate of 2 liters of oxygen consumption per min will maintain his thermal status if he is permitted to evaporate 0.75 liter of sweat per hr, provided he is not gaining additional heat from his environment.

The transfer of heat from deep inside the body to the periphery is primarily a function of the cardiovascular system which must deliver an adequate quantity of blood not only to the working muscles, but also to the skin both for cooling and for supplying the active sweat glands.

One Fluid—the Blood

Man possesses only one fluid, the blood, to insure an adequate fuel supply to the muscles and also to take care of heat dissipation. This is in contrast with a combustion engine where energy is provided by feeding gasoline to the engine and cooling depends on water circulation. Since the total blood volume is limited, the more blood needed to meet the requirements of the working muscles the less blood available to cool the body. The requirements of the muscles have priority.

Adequate cooling can be insured only when the work level is low enough to permit a sufficient distribution of blood to the skin in order to maintain thermal equilibrium. When the work level increases, more blood will go to the muscles, heat dissipation will become inadequate, and body temperature will rise.

An additional strain on the cardiovascular system will occur if dehydration develops. As perspiration becomes

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[1] Condensed from "Heat Stress and the Industrial Worker," by Lucien Brouha, Paul E. Smith, Jr., and Mary E. Maxfield, all of the Haskell Laboratory for Toxicology and Industrial Medicine, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. ASME Paper No. 59—A-213.

Based on four papers contributed by the Heat Transfer Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of The American Society of Mechanical Engineers.

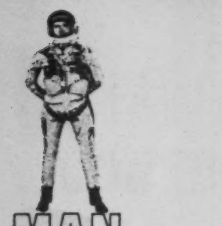
Eight papers on biological heat transfer were presented this year, four of which are offered here in condensed form. All eight can be obtained through the ASME Order Department in the usual manner. The four which are not here condensed are:

L. P. Herrington, "Prediction of Heat Stressed Skin Boundary Temperatures; Partial Rates of Change Associated With (*a*) Operative Temperatures and Vapor Pressure, (*b*) With Operative Temperature, Metabolism, and Evaporation." ASME Paper No. 59—A-209.

E. Hendler and J. D. Hardy, "The Effective Stimulus for Warmth Sensation in Man." ASME Paper No. 59—A-208.

T. H. Benzinger, "Sensory Reception and Control of Temperature in Man." ASME Paper No. 59—A-214.

Alice M. Stoll, "The Role of Skin in Heat Transfer." ASME Paper No 59—A-138. This last paper will appear in the *Journal of Heat Transfer—Trans. ASME.*



MAN *and his thermal environment*

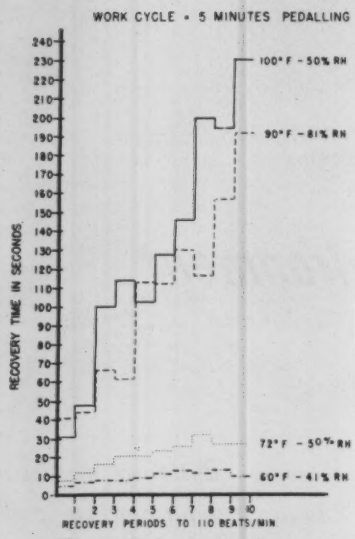

WORK CYCLE • 5 MINUTES PEDALLING
100°F - 50% RH
90°F - 81% RH
72°F - 50% RH
60°F - 41% RH
RECOVERY TIME IN SECONDS
RECOVERY PERIODS TO 110 BEATS/MIN

Fig. 1 Work plus environment. This graph shows the time-of-recovery to 110 heart beats per min after ten successive work periods lasting 5 min each.

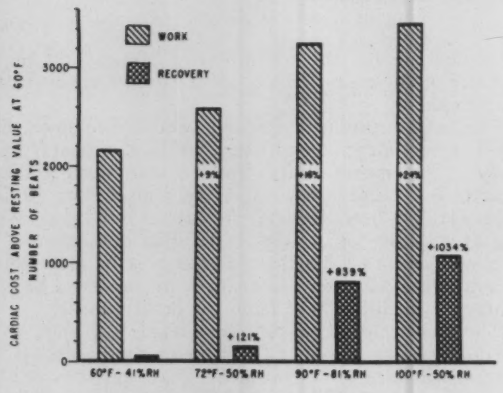


Fig. 2 The same experiments, graphed in terms of "cardiac cost"—ten work periods, and ten partial recoveries, in four environments.

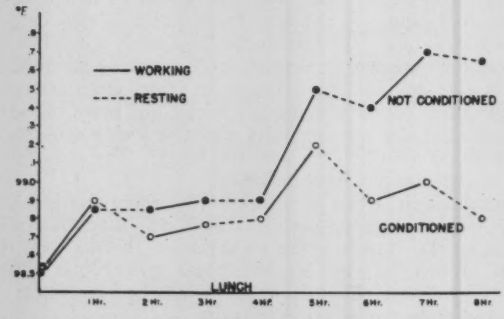


Fig. 3 Average body-temperature variations during an 8-hr shift with and without air-conditioned rest rooms. Cool surroundings diminish thermal stress.

profuse, large amounts of body fluid will be lost and, unless replaced by fluid intake, will result in dehydration. This will lead to a decrease in blood volume and a concomitant increase in blood viscosity.

If the work load is excessive in a favorable environment or if the heat stress is excessive for a light work load, no physiological reaction can be maintained in a steady state and there is a progressive approach to exhaustion as work continues. Sooner or later the subject must stop and the recovery processes are extremely slow.

Evaluating the physiological stress produced by a warm environment is not easy but is important from the industrial-engineering point of view. What is the limit of tolerance for man working in hot surroundings? How much can be reasonably expected of the worker? How often and for how long should he be able to rest and recover during a shift?

How to Measure Heat Stress

Several indexes have been devised for evaluating the stressing effect of work plus environment. They have been shown to be more or less reliable when compared with the actual strain affecting the worker.

Laboratory experiments and surveys in numerous plants under widely different environmental conditions have convinced us that the most precise way to assess the effect of an environment is to measure the physiological reactions it produces on man. Man is the best tool to determine the effect of work stress and heat stress upon himself. It is logical that it should be so if one considers the variability among individuals and the variability within the same individual.

Body temperature and heart-rate changes have proved to be two simple and valuable measurements in assessing the physiological status of an individual or of a group of workers.

Fig. 1 shows the time needed to return to a heart rate of 110 beats per min after performing in four different environments. The increase in recovery time between successive cycles is very small at 60 and 72 F; but when the temperature reaches 90 to 100 F, the recovery time lengthens considerably between each performance.

Fig. 2 presents the results of the same experiments expressed in cardiac cost. In this case, cardiac cost of work is the total number of extra beats above the resting heart rate that was needed to perform the ten work cycles. The cardiac cost of partial recovery is the total number of extra beats that occurred before the heart rate returned to 110 beats per min for the ten recovery periods. Whereas the work cost increased only comparatively little with more severe environmental conditions, the recovery cost increased very markedly.

If continuous recording of heart rate and body temperature during work is easy in laboratory experiments, it is not practical in plant surveys. Measuring heart rate and body temperature during the first part of the recovery period following a work cycle fortunately yields valuable results and permits a sufficiently precise evaluation of the worker's strain.[2]

Fig. 3 shows the different patterns that were recorded for body-temperature variations under conditions in which workers spend their rest periods in air-conditioned rest rooms; the recovery processes were hastened and complete so that the cardiovascular reactions were considerably reduced both during work and during recovery.

[2] L. Brouha, *Advanced Management*, January, 1954.

It illustrates the drastic diminution in thermal stress which is achieved by recovering in cool surroundings.

Summary

Except under conditions of light work and favorable environments, the efficiency of the body-cooling mechanisms depends on the amount of sweat that can be produced and evaporated. When sweating decreases because of dehydration or when perspiration cannot evaporate adequately because of the high humidity of the atmosphere, heat stress develops rapidly even at comparatively low levels of work. The amount of heat stress can be satisfactorily assessed by measuring pulse-rate and body-temperature variations.

When a job has been recognized as producing high reactions either because of the work load, or heat exposure, or both, various improvements can be made. They must be evaluated in terms of physiological values until a satisfactory solution is found.[3]

In many industrial operations heat remains the main factor of stress and low productivity. Adequate measures to combat it are available and should be adopted for the benefit of the workers as well as management.

[3] L. Brouha, MECHANICAL ENGINEERING, June, 1958, p. 81.

Heat Stress in the Desert[4]

By Austin Henschel and H. E. Hanson

SIXTEEN volunteer enlisted men comprised a subject group to investigate the role of solar radiation, clothing, and energy expenditure in the total heat load imposed on men in a desert environment.

Eight basic combinations of conditions were studied (see Table 1). The physiological variables used to assess the impact of the exposures were rectal temperature, pulse rate, sweat production, and sweat evaporation.

The environmental conditions during the hours of exposure were: Air temperature 101.7 F, range 96 to 108 F; humidity 25 per cent, range 9 to 44 per cent; wind 7 mph, range 3 to 14 mph; solar radiation 886 cal/m²/hr, range 762 to 944 cal/m²/hr.

Clothing worn consisted of cotton shorts, socks, boots, and visor cap during nude trials. During clothed trials, the standard Army desert uniform was also worn. Work consisted of walking for 2 hr at 3 mph over desert terrain. At rest the men sat on wooden boxes about 16 in. high. For shade a large tent, 100 × 40 × 18 ft with eaves rolled up 8 ft above ground level was used; a walking course was laid out inside the tent-shaded area. Clothed and nude body weights were measured at the beginning and at the end of each 2-hr test period. Water intake was ad lib, but measured, and was used in calculating changes in body weight and total sweat production. Evaporated sweat was calculated as the difference between total sweat and sweat picked up in the clothing.

Results

The mean values of the variables measured for the eight combinations of conditions are presented in Table 1.

Table 1 Average Value of Physiological Variables Measured

Condition	ShCR	ShNR	SCR	SNR	ShCW	ShNW	SCW	SNW
Total sweat, gm/2 hr.....	962	1237	1400	1934	2070	2194	2542	2726
Evap. sweat, gm/2 hr.....	923	1212	1335	1903	1888	2151	2318	2695
ΔT_R, deg F.....	0.05	0.10	0.20	0.31	0.89	0.98	1.09	1.06
Final pulse rate.	74	76	78	81	107	107	112	113

ShCR = shade clothed rest
ShNR = shade nude rest
SCR = sun clothed rest
SNR = sun nude rest
ShCW = shade clothed work
ShNW = shade nude work
SCW = sun clothed work
SNW = sun nude work
ΔT_R = rectal temperature rise during the 2-hr period.

[4] Condensed from "Heat Stress in a Desert Environment," by Austin Henschel and Harold E. Hanson of the Environmental Protection Research Division, Quartermaster Research and Engineering Command, Natick, Mass. ASME Paper No. 59—A-210.

(The paper breaks down the data into more tables, showing the response produced by exposure to the sun, the extent to which clothing altered the response, and the effects of work.)

Effect of the Sun. On exposure to sun, irrespective of the state of dress or level of work output, statistically significant increases in sweat production and sweat evaporation occurred. Small but consistently higher pulse rate and rectal temperature were observed under all conditions when the men were exposed to the sun. Both the amount of clothing worn and the level of energy expenditure influenced the effect of the exposure to the sun. In the sun more sweat was produced and evaporated than in shade.

The clothed men at rest received about 120 Kg cal per hr from the sun, 125 Kg cal per hr during clothed-work, 160 Kg cal per hr during nude-work, and 200 Kg cal per hr during nude-rest. The higher value for the nude-rest situation probably reflects the heat transmitted by long-wave radiation from the hot desert surface.

Effect of Clothing. A statistically significant decrease in sweat evaporation and sweat production (except for work-shade which approached significance) occurred under all conditions with the donning of clothing. Calculated in terms of decreased heat gain from the environment, clothing provided significant protection. The men were able to maintain pulse rate and rectal temperature with a reduced rate of sweat production. Pulse rates and rectal temperatures were not, however, significantly lower when clothing was worn.

The decrease in environmental heat gain with the wearing of clothing was more pronounced during rest than during corresponding work conditions. Similarly, environmental heat gain was less in the sun than in the shade for both levels of energy expenditure.

Effect of Work. The effect of work was to increase significantly sweat production, sweat evaporation, pulse rate, and rectal temperatures in all combinations of sun-versus-shade and nude-versus-clothing conditions.

The difference in sweat production and sweat evaporation was significantly less for the nude-sun condition than for any of the other combinations. This probably reflects the appreciably higher sweat rate that occurred even when the men rested in the sun while nude. The much higher pulse rates and rectal temperatures in all work combinations emphasize the extent to which the level of energy expenditure under summer desert conditions can be a limiting factor in heat tolerance.

MAN *and his*

thermal environment

Discussion

Apparently with air temperature higher than skin temperature and ground-surface temperature high, clothing shielded against both solar and long-wave radiation.

Measurements have shown that under desert conditions the ground surface may be 30 to 40 deg F hotter than the air (Sissenwine, et al). The total heat from long-wave radiation would be higher when the subjects were seated at rest near the hot ground surface than when standing or walking. The difference in heat gain by the clothed and nude men at rest in the sun and shade reflects the relative protection against long-wave radiation afforded by the clothing worn.

The over-all reduction in heat load from the environment was reduced about one third by the clothing. Because the clothing used offered little resistance to the evaporation of sweat, it did not interfere with the dissipation of the metabolic heat by that route.

The level of energy expenditure was the major factor in determining the total heat load on the subjects. All of the physiological parameters measured responded significantly to the stress imposed by the work. The relative impact of the work as measured by sweat production and evaporation was greater for the periods when clothing was worn than for nude conditions. This was due to the higher sweat production and evaporation when the men were resting nude.

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Aerodynamic Heating[5]

by Paul Webb

One of the hazards in modern military flying is exposure to heat which originates on the surface of the aircraft as it passes rapidly through the atmosphere. The pilot's compartment is cooled, but should the cooling system fail there would be a rapid rise in temperature until the aircraft could be slowed down. In a space vehicle, which re-enters the earth's atmosphere, great heat is generated. The re-entry period is fairly brief, except in the case of hypersonic gliders. Again, some failure in the method of cooling would cause exposure of the occupants to rapidly increasing temperature. Or a brief period of high temperature might be included in the flight profile of a re-entry vehicle, so long as occupants and heat-sensitive equipment can tolerate it, in order to save the weight and power ordinarily spent in mantaining a cool interior.

The rate and magnitude of heating in the aircraft cabin have been suggested in two engineering studies, one for a hypersonic glider, and the other for a manned re-entry vehicle. Kordenbrock [1][6] predicted, in the event of air-conditioning failure during the re-entry of a boost glide vehicle, a wall temperature increase of 70 F per min until 500 F was reached. Another study by Carter and Bell [2] predicted a wall temperature increase of 60 F per min to 800 F.

[5] Condensed from "Exposure to Aerodynamic Heating Transients," by Paul Webb, M.D., Yellow Springs, Ohio. ASME Paper No. 59—A-211.

[6] Numbers in brackets designate References at the end of the paper.

Slow Heat Pulses

Rapidly increasing temperatures of this kind will here be called "slow heat pulses" as contrasted with "fast" heat pulses such as explosions, flash fires, and thermal pulses in nuclear explosions (Buettner [3] and Hardy [4]). A slow heat pulse is a condition of increasing temperature which reaches a high level of physiological stress in a period of minutes. It has become important to define man's tolerance to slow heat pulses to discover what protection might be helpful.

It seemed that the heat exposure might be so severe that surface pain and burning would occur before there was a significant amount of body heat storage.

Experimental Chambers

A small chamber was made at the Aero Medical Laboratory, Wright Air Development Center (WADC), to conduct preliminary tests; first results were reported [5] but not published in detail. Later, at the Firewel Company in Buffalo, another chamber was constructed, this time with dimensions more closely resembling those of an aircraft cockpit. Studies have been carried out in these chambers to determine man's tolerance to slow heat pulses, including the effect of protective garments.

The two chambers used are shown diagrammatically in Figs. 4 and 5,

The WADC chamber was made of a single thickness of lightweight aluminum, heated externally by banks of high-intensity radiant lamps (General Electric Type T-3). The Firewel chamber was a double-walled aluminum structure which contained heating rods similar to those used in kitchen electric ranges. In the studies reported here the highest heating rate employed in a slow heat pulse was 100 F per min.

The Firewel chamber was equipped with a ventilating air supply for clothing.

In the experiments, the exposure was carried to the point where the subject called a halt due to unbearable pain. The level of unbearable pain, rather than threshold pain, was chosen. Experience was similar to Neisser's [6], who found in general less variation between individuals with this end point than he found for threshold pain.

Results

Exposure to slow heat pulses with slopes ranging from 15 F per min to 100 F per min with nude subjects resulted in intolerable pain at temperatures between 325 F and 400 F. The faster the rate of temperature rise, the higher the temperature which could be tolerated.

A lower maximum temperature was tolerated at the slow rates. This would likely be a cumulative effect of the longer exposure. Thermal inertia of the skin has been shown by Stoll and Greene [7] to increase as the level of irradiance increases. The thermal inertia of the skin is of greater protective value at the rapid rates of rise, permitting one to tolerate a higher wall temperature when the heating transient is steep.

Discomfort in breathing was closely related to air temperature rather than to wall temperature. At a level of 260 F air temperature most subjects voluntarily changed from nasal breathing to mouth breathing, and at 300 F air temperature, mouth breathing also became uncomfortable. Relief was found by breathing through one's fist or, in the later experiments where clothing was used, breathing through gloves or sleeve material, acting as passive heat exchangers.

Fig. 7 shows the result of exposure to slow heat pulses when clothing of increasing weight was used. The heavier the assembly (i.e., the more layers or the greater the thickness) the higher the temperature which could be tolerated. The best protection was given by a heavy coverall (Fig. 6) which had an aluminized outer surface worn with protective boots, gloves, and a helmet.

The aluminized coverall with ventilation converted the heat exposure to a situation where tolerance was reached after many minutes due to heat storage. Using 10 cfm of air delivered at a temperature of 70 F and with a water-vapor pressure of approximately 5 mm mercury, subjects have remained for longer than 15 min at the 500 F wall temperature.

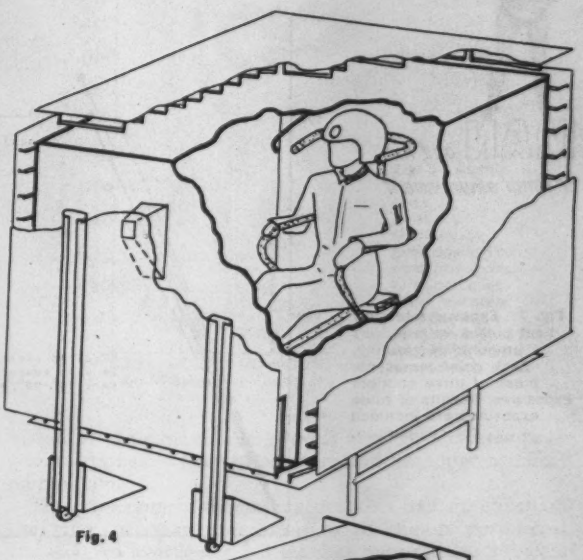

Fig. 4

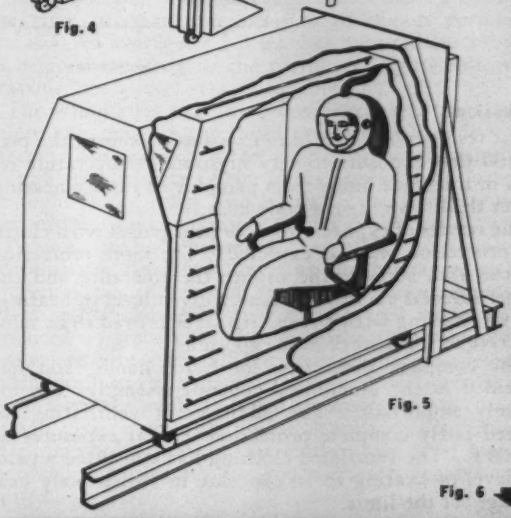

Fig. 5

Fig. 6

Fig. 4, top The WADC chamber, a 4-ft cube with a movable front wall, mounted on casters. Heating lamps on sheet reflectors are spaced above each wall.

Fig. 5, center The Firewel chamber, showing the heated top, side, and bottom walls, and unheated front wall, mounted as a unit on a track. Heating was through manual switches or electrical relays with automatic control devices.

Fig. 6, photo Showing a subject in place in the Firewel chamber. The aluminized coverall, with ventilation, is shown while ventilating air is passing through, causing ballooning of the trunk, arms, and legs.

MAN *and his thermal environment*

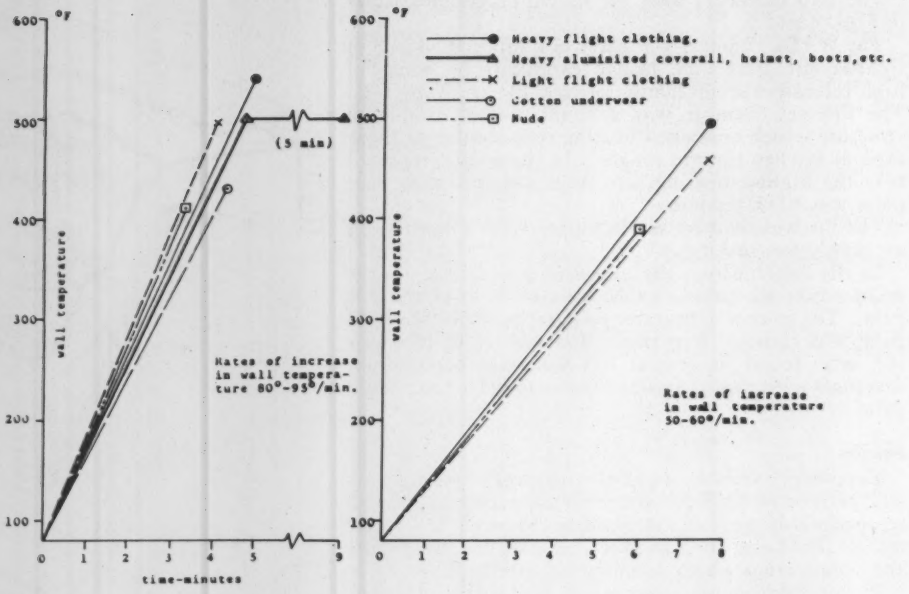

Fig. 7 Exposures to slow heat pulses with various amounts of clothing. Each point represents mean of three or more exposures. Results of nude exposures are included for comparison.

Discussion

The result of the bare-skin exposures confirms the prediction that exposure to very high wall temperature results in tolerance limits from pain due to surface heating rather than to storage of body heat.

The results of exposure to slow heat pulses with clothing protection were as expected. The more protection for the skin surface, the higher the tolerance and the longer subjects could withstand a given level of heating. Heavy clothing with a reflective layer proved to be most effective in this sort of heat exposure.

The complete protection for head, hands, and feet provided in the aluminized coverall assembly was extremely important. The addition of ventilating air offered fairly complete protection in heat exposures up to 500 F. The ventilated clothing had converted a painful level of heating to an exposure in which body heat storage set the limit.

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4 J. D. Hardy, "Thresholds of Pain and Reflex Contraction as Related to Noxious Stimulation," *Journal of Applied Physiology*, vol. 5, 1953, pp. 725–739.

5 P. Webb, "Protection of Man Against Transient Exposure to High Heat Loads," in "Advances in Astronautical Sciences," vol. 4, American Astronautical Society, New York, N. Y., 1959, pp. 418–419.

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Tolerance to Acceleration[7]

By B. F. Burgess, Jr.

This work[8] establishes a realistic maximum temperature that one can normally be expected to endure, with only ordinary clothing, while being subjected to intermittent positive acceleration for periods of 1 hr or longer.

The change in tolerance to acceleration was used as the criterion for determining the over-all efficiency of the various compensatory mechanisms of the body in com-

[7] Condensed from "The Effect of Temperature on Tolerance to Positive Acceleration," by Benjamin F. Burgess, Jr., Commander, MSC, USN, U. S. Naval Air Development Center, Aviation Medical Acceleration Laboratory, Johnsville, Pa. ASME Paper No. 59—A-212.

[8] Opinions or conclusions contained in this report are those of the author. They are not to be construed as necessarily reflecting the views or endorsements of the Navy Department.

bating the stress imposed by the high environmental temperatures.

Peripheral light loss was used as the physiological end point.

The experimental plan was this: Six trained centrifuge subjects received positive acceleration in an environmental temperature that ranged from 75 to 160 F. The relative humidity, which was not controlled, ranged from 55 per cent at the lowest temperature to 90 per cent at the highest temperature (dew point approximately 155 F). The gondola of the Johnsville centrifuge was equipped with heaters that were able to maintain a constant temperature with an accuracy of ±1 F.

The gondola was equipped with a standard aircraft seat and the instrument panel contained the commonly used jeweled lights; i.e., a single red light at the center of the visual field for fixation, and two green lights placed laterally for peripheral vision. A small control stick was suitably located on the right arm rest by which the subject controlled the peripheral lights. The subject kept his eyes fixed on the central light and turned off the peripheral lights by moving the control stick in the proper direction. The peripheral lights were turned on in a randomized sequence by a punched-tape device, and were never on at the same time. The subject turned them out by moving the stick to the right to extinguish the right light and to the left for the left light.

Seven copper-constantan thermocouples were placed at various locations on the subject's body. The subject then donned a standard summer flight suit and entered the centrifuge gondola which had been previously heated to the temperature under investigation. Immediately a static run was made with the subject answering the lights and a record was made of his skin temperatures, respiratory rate, heart action, light error, and reaction time.

Recordings of these factors were made for all centrifuge runs. The electrocardiogram was monitored carefully to detect any cardiac abnormalities which would warrant cessation of the run.

The first g-level was always 2 g. Each successive run was increased by 0.25 g up to the point of peripheral light loss. The rise time to peak g was always 7 sec and peak g was maintained for 15 sec except for some special runs. The final run in each series lasted 4 min, at a level 0.25 g below that producing peripheral light loss. There was a 3-min rest period between all runs and a complete series required the subject to remain in the gondola for approximately 1 hr.

Lowered g-Tolerance

Each subject rode the centrifuge every day for a period of 3 weeks. Each day's work consisted of approximately eight rides at the particular temperature under investigation. Fig. 8 shows the average decrease in g-tolerance caused by the various temperatures. The lowest temperature to produce any degradation in g-tolerance was 100 F, where a decrement of approximately 0.2 g-units was observed. At 160 F, the maximum temperature studied, there was an average decrease of 1.0 g.

The experiment was terminated at the 160 F level because the skin temperature had reached 102 F and symptoms of impending heat exhaustion were prevalent. Obviously, the heat-regulating mechanisms could no longer compensate for the high environmental temperature.

The average time required for subjects to lose peripheral

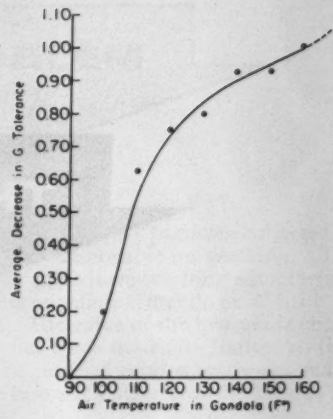

Fig. 8 As the temperature goes up, a man's G-tolerance goes down. The experiment was terminated at 160 F because men showed symptoms of impending heat exhaustion.

vision at their maximum g-levels was 3.0 sec after peak g was attained. The temperature had no apparent effect on this time.

The environmental temperature also had no effect on the time necessary for subjects to regain peripheral vision. An average of 3.8 sec was required for subjects to begin responding to the peripheral lights following grayout, the g-level remaining constant.

The 4-min runs that were conducted at a level 0.25 g below the grayout threshold produced no undesirable effects. The subjects never lost peripheral vision although the intensity of the lights appeared to fluctuate throughout the run. The lights become brighter with each inspiration and dimmer during expiration.

Previous studies[9,10] showed that high environmental temperatures produced lowering in tolerance to acceleration in both man and animal. We were rather surprised to find, however, that the elevated temperatures produced no significant change in the time required to respond to visual stimuli until we reached the level of impending heat exhaustion. On several occasions at the 160 F level the subjects failed to answer the lights although they reported the lights as appearing bright and clear. Co-ordination at this temperature level became poor and the capacity for concentration became very limited.

Sequence of Sensations

There was a striking similarity between the central nervous system symptoms produced by the combination of heat and acceleration and that produced by hypoxia and acceleration shown in previous studies.[11] During the stages of maximum stress in both of these experiments the subjects at first experienced euphoria which shortly turned into a feeling of restlessness and finally manifested a decreasing ability to carry out instructions and perform relatively simple tasks.

Acceleration patterns of 4 to 5 g used in this study may be relatively mild when compared to those anticipated in future space flight.

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[9] E. U. Chae, "The Influence of Temperature Upon the Tolerance of Mice to Positive Radial Acceleration," *Journal of Aviation Medicine*, ROKAF, vol. 5, No. 1, 1957.

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THE PROBLEM

by STAN JEWSON

The Low Level Economizer

A DESIGN STUDY

by J.H. POTTER and R.C. KING

A study of the economizer's construction and performance, judging it in terms of the effect it will produce in the over-all system

A SUBSTANTIAL fraction of the chemical energy of the fuel used in thermal power generation is contained in the flue gases which pass out to the atmosphere through the stack. The extent to which the flue-gas energy can be recovered is limited by the increasingly severe corrosion in the recovery devices.

A low-level economizer can be installed in the gas circuit to recover a greater than usual portion of the energy in the products of combustion. It is believed that the application of such a unit for a 100,000-kw central station shows great promise. An extended-surface-type unit made of cast iron has been used as the basis for calculations over a wide range of loads and ambient air temperatures.

Based on two papers contributed by the Process Industries and Power Divisions and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

THE PROBLEM

by STAN JEWSON

THE thermal efficiency of power generation has improved steadily for more than 100 years. Power-generating companies have come to accept as a matter of course that each new unit installed will be more efficient than the last. A point has now been reached where appreciable efficiency increases can only be accompanied by large increases in capital expenditure, and in many cases the benefits are not justifiable economically.

In the past, most of the effort to obtain higher energy conversion has been directed along two main avenues. First, the spread between the initial and final enthalpy of the steam is increased by using higher working temperatures and pressures and by the use of multiple reheat. Second, by extension of the regenerative feedwater heating cycle the condenser losses are reduced.

Pressures and temperatures are limited by the availability of suitable materials. Advances in this direction can only be in step with metallurgical developments. The number of reheat and feedwater-heating stages is limited economically. The most modern power plants which have as many as nine stages of feedwater heating and two stages of reheat are considered to have reached the point where further efficiency increases from additional stages cannot be economically justified.

One avenue of possible savings which has been left relatively unexplored in recent years is the extraction of low-grade energy from flue gases. The exit-gas temperature from the conventional heat exchangers of large steam plants varies between 320 and 250 F depending on the type of fuel.

Construction

The low-level economizer is a heat exchanger specially designed to allow power boilers to operate with low stack temperatures without the inconveniences normally experienced with conventional heat exchangers. Stack temperatures of 200 F and below are now within the reach of almost every steam-plant user.

Each low-level economizer must be designed to suit the requirements of each particular plant, but there are certain design requirements which should apply to all low-level heat exchangers:

1 Heat-transfer surfaces must be manufactured from materials having a resistance to sulfuric-acid corrosion.

2 Because of the limited temperature difference available for heat transfer, large surfaces are necessary. In order to contain the heat exchanger within a reasonable space envelope, extended-surface elements must be employed.

3 Fly-ash particles collected on low-level-economizer heating surfaces will be sticky in nature and will have a strong plugging tendency. In order to prevent the rapid build-up of operating draft losses, the gas passages through the economizer must be as large as is practicable.

4 The fly-ash particles collected on heating surfaces are only removable by washing. The low-level economizer must have washing equipment capable of washing the economizer either on or off load.

5 The value of the low-grade energy extractable from the flue gases is strictly limited so that if the recovery is to be justified economically the manufacturing costs of the heat exchanger must be kept as low as possible.

The choice of materials for the production of low-level economizer elements is limited. Special corrosion-resistant alloy steels have been produced and have been used successfully in heat exchangers to prevent corrosion. However, with the large surfaces required in low-level economizers, the high cost of special alloy steels prohibits their use.

Cast iron is favored for the manufacture of low-level-economizer elements because it has a resistance to sulfuric-acid corrosion up to 10 times that of regular carbon steel and, pound for pound, it costs considerably less than the latter. In addition, cast iron can be cast readily into almost any desirable shape in one operation.

Applications

It is impossible to evaluate all the applications of the low-level economizer. The economic justification of any low-level heat-recovery scheme is influenced by many factors, and schemes which prove economically attractive in one plant may be uneconomical in another.

Indirect Air Preheating

To protect the cold-end surfaces of regenerative and recuperative air heaters from plugging and corrosion, it is common practice to install steam coils to preheat the air leaving the forced-draft fan, before it enters the air heater proper. In winter, and in some plants the year round, the expense of steam preheating is heavy. Bled steam used for air preheating constitutes a direct loss in power generation. A low-level economizer can supply all the heat required for air preheating and, at the same time, improve the station heat rate and increase the unit peak capability.

Cleaning the Economizer

The deposits which occur on the surfaces of conventional high-level economizers and air heaters are normally dry and can be removed by blowing with steam or compressed air. More stubborn deposits, against which blowing has proved ineffective, can be successfully removed by shot-cleaning. The deposits which occur on low-level economizers consist of sticky fly-ash particles which do not usually respond to either blowing or shot-cleaning

Shot-cleaning is effective in removing the deposit in some cases, but difficulty is usually experienced in separating deposit from the shot. The sticky deposits have a snowball effect on the shot particles and in some cases the shot assists in plugging the heating surfaces

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The Low Level Economizer

A DESIGN STUDY

by J. H. POTTER and R. C. KING

PARAMOUNT to possible improvement in economy resulting from a recovery of a larger portion of the flue-gas energy is the realization that the energy which is recovered from stack gases must be returned to the cycle. No gain would result from a reduction in stack temperature, for example, by exchanging heat with the atmosphere alone.

An existing 100,000-kw installation at an altitude of 5000 ft, burning coal, oil, or natural gas, was selected as the basis for the present study. The cycle, Fig. 1, consists of a steam-generating unit, turbine-generator unit, two low-pressure feedwater heaters, a deaerator, two high-pressure feedwater heaters, an evaporator, and the usual complement of auxiliaries.

The boiler is of the radiant type; the superheater is part radiant and part convective. The reheater and main economizer are located in the convection zone. Steam-temperature control is by injection of desuperheat water and by gas recirculation. A regenerative air heater is installed. Throttle pressure and temperature are 1450 psig, 1000 F, with reheat to 1000 F.

Two low-level-economizer applications, air tempering and feedwater heating, were selected for study. Heat-balance diagrams for 110,000 kw (maximum expected throttle flow), 75,000 kw, 50,000 kw, and 25,000 kw were available for the actual plant design. These balances were used in the study and were designated arbitrarily as $^4/_4$, $^3/_4$, $^2/_4$, and $^1/_4$ load, respectively. All calculations involving air and gas quantities and temperatures were based on a midwest coal having the following proximate analysis: moisture, 13 per cent; volatile matter, 35.2 per cent; fixed carbon, 39.6 per cent; ash 12.2 per cent. The sulfur content was 4.39 per cent and the higher heating value was 11,200 Btu per lb.

Tempering of Combustion Air

It is well known that, in order to prevent corrosion of the regenerative air heater, it is necessary to provide a so-called minimum cold-end temperature which is the arithmetic average of the temperatures of the entering air and leaving gas, uncorrected for air leakage. For the coal selected for this installation, the manufacturer recommended a cold-end temperature of 210 F.

In the conventional arrangement, a tempering coil in the air stream ahead of the regenerative heater is heated either by steam extracted from the turbine cycle or by the condensate that has passed through one of the main-cycle feedwater heaters. The tempering scheme utilizing steam extracted from the turbine has been selected arbitrarily for comparison with the low-level-economizer installation.

In the air-tempering arrangement with the low-level economizer, Fig. 2, flue gases pass over the finned economizer surface and heat is transferred to a closed liquid loop which serves the air-tempering coil, and cool liquid is returned to the low-level economizer by a pump. Water, having a constant specific heat of unity, has been assumed, although a nonfreezing mixture such as water and ethylene glycol might be used for outdoor installations. The economizer has been arbitrarily located downstream of the dust collector and induced-draft fan to reduce the deleterious effect of possible corrosion to a minimum, and to recover the energy added by the induced-draft fan.

For outputs ranging from $^4/_4$ to $^1/_4$ plant load, the gas temperature (uncorrected for leakage) at exit of the regenerative air heater is shown in Fig. 3 as a function of the air temperature entering the heater. Also plotted is the locus of 210-F minimum cold end temperature. At full load, an air temperature of 105 F is required at entrance to the regenerative heater, while at $^1/_4$ load, an air temperature of 138 F is required.

Basis of Calculations

Conventional Arrangement. For purposes of steam-tempering-coil selection, the source of steam supply was taken as the deaerator steam-extraction line. A three-row coil which gives protection to the desired −20-F ambient condition was used in the calculation. Condensate from the steam-tempering coils is returned to the main plant condenser. The total installed cost of the steam-tempering coils including all piping, traps, and control valves would be about $25,000.

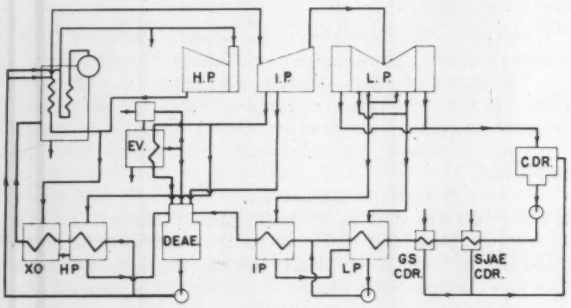

Fig. 1 Basic station cycle for the 100-mw existing plant used as a basis for the study

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Condensed from Paper No. 59—A-222.

The gross electrical generation at each of the four throttle flows was determined with and without steam tempering, as well as differential FD and ID-fan power requirements caused by the presence of the tempering coil and economizer. It was assumed that all other auxiliary powers remained constant. Then the net generation at each of the four throttle flows was obtained by difference. The heat rate at each approximate load point with steam tempering was also calculated.

The air and gas quantities and temperatures, as specified by the boiler manufacturer, for each load condition are shown in Table 1. The steam-generating-unit furnace operates under a slight suction, and steam-temperature control is partly by gas recirculation.

Table 1 Basic Air and Gas Data

Load	Air leaving heater		Gas entering heater	
	Lb/hr	Temp., F	Lb/hr	Temp., F
4/4	865,000	568	1,056,000	677
3/4	620,000	543	765,000	630
2/4	491,000	538	615,000	612
1/4	320,000	534	390,000	595

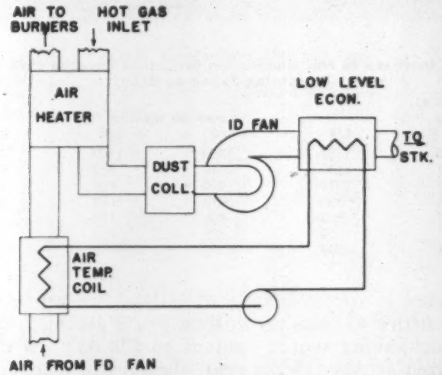


Fig. 2 Low-level-economizer and air-tempering-coil arrangement. Flue gases pass over the finned economizer surface and heat is transferred to a liquid loop which gives up a portion of its energy to the entering air when passing through the air-tempering coil.

With Low-Level Economizer. The low-level economizer was selected to match the regenerative air heater furnished as a part of the steam-generating unit without regard for optimization. It is of all cast-iron construction and would be in two separate units of 240 tubes each, arranged 10 tubes high, 12 tubes deep, and 2 tubes wide. The over-all dimensions of each of the two units would be 6 ft 2 3/4 in. high, by 23 ft wide, by 8 ft 1 in. deep. Operating weight would be about 167,000 lb for each unit. Estimated erection time is 1975 man-hours. The cost of the complete installation is estimated at $175,000. Operating experience over a number of years may indicate that the special anticorrosion treatment of flue breeching and stack that was assumed in the study is unnecessary and the cost could be saved.

The differential forced-draft and induced-draft fan powers for the four basic loads were conservatively calculated. The energy requirements were also estimated, and the decrease in heat rates as a function of ambient-air temperature is shown for all four loads in Fig. 4.

Performance Characteristics. Pertinent performance characteristics of the economizer and tempering-coil in-

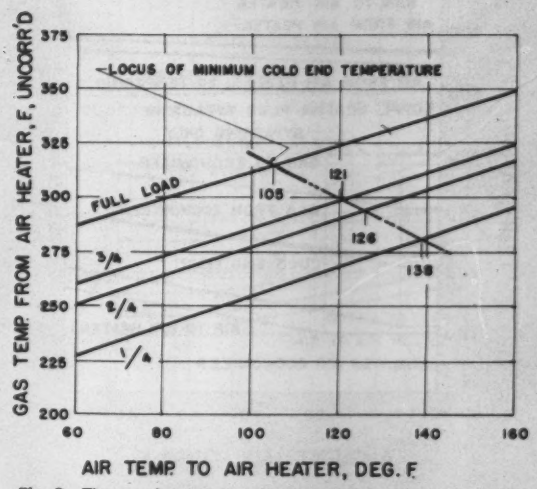


Fig. 3 The gas temperature (uncorrected for leakage) at the exit of the regenerative air heater as a function of the temperature entering the heater. The locus of the 210-F minimum cold-end temperature is also plotted.

stallation are shown graphically in Figs. 5(*a*) through (*d*). Two basic requirements must be satisfied by the installed equipment: (*a*) The air heater must be protected by means of supplying air at a sufficiently high temperature to match the minimum cold-end requirement; (*b*) the economizer must be supplied with water at a sufficiently high temperature so that the base of the extended surface will be safely above the water dewpoint. The air-heater manufacturer specified 210 F as the minimum cold-end temperature; the economizer manufacturer specified 100 F as the minimum water temperature at economizer inlet.

At full load at 16-F ambient and below, a control scheme embodying an automatic temperature-controlled bypass valve and a supplementary steam heater was assumed, Fig. 6. The bypass valve opens automatically whenever economizer-inlet water temperature reaches 100 F. The supplementary-heater steam-inlet valve opens whenever the arithmetic average of the regenera-

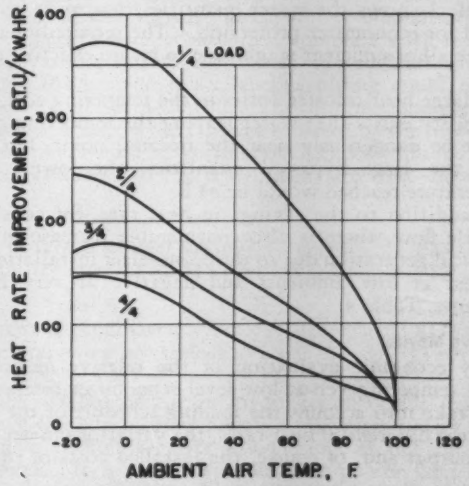
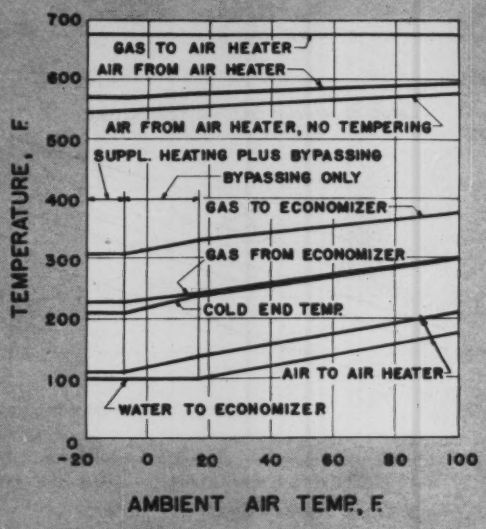


Fig. 4 The heat-rate improvement of the low-level economizer versus steam tempering; the decrease in heat rates as a function of ambient-air temperatures is shown for all four loads.



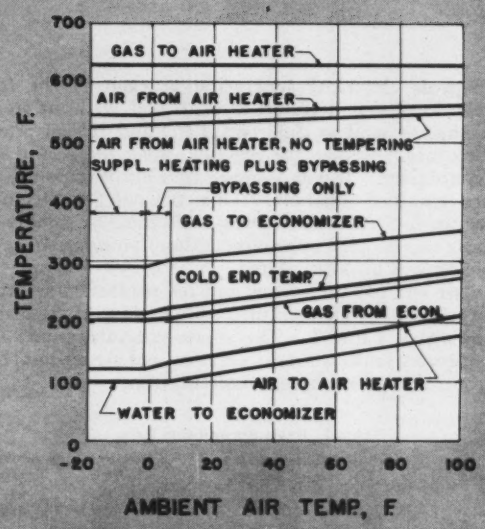


Fig. 5 Low-level-economizer performance: (a) At 4/4 load, (b) 3/4 load,

Table 2 Supplementary Heat Requirements, Millions of Btu per Hr

	Ambient temperature	
Load	−20 F	0 F
4/4	2.70	0
3/4	2.90	0
2/4	1.20	0
1/4	2.23	0.67

Table 3 Flow Through Bypass, Lb per Hr

	Ambient temperature	
Load	−20 F	0 F
4/4	110,000	79,000
3/4	103,000	81,000
2/4	118,000	0
1/4	0	0

tive-heater air-inlet and (uncorrected) gas-outlet temperatures reaches 210 F. Table 2 shows the supplementary heating requirements. It was assumed that this steam would be supplied at reduced pressure from the steam drum of the boiler.

Table 3 shows the water quantities that must be bypassed for economizer protection. The required quantities are all of sufficient magnitude to insure effective control.

At large heat-transfer duties in the tempering coil, the possibility exists that water leaving the tempering coils might be dangerously near the freezing point, but despite the large bypassed quantities, the lowest exit temperature reached would be 43 F.

In addition to the savings in heat rate, for constant throttle flow, there is also considerable increase in net electrical generation due to the economizer installation—greatest at low ambients and negative at very high ambients, Table 4.

Relative Merits

Any economic evaluation of the relative merits of steam tempering versus low-level-economizer tempering must take into account the loading schedule of the station, the differential heat rates, the variations in net station output and, of course, the installed costs of equipment.

With the loading schedule of Table 5 and the differential heat rate curves of Fig. 4, the saving in the form of fuel is

Table 4 Increase in Net Generation for Equal Throttle Flow (Steam Tempering Taken as Base)

Ambient temp, deg F	Load on station 4/4	3/4	2/4	1/4
−20	1755	1400	1100	735
0	1380	1145	920	630
20	1035	900	730	515
40	690	670	560	410
60	350	450	390	315
80	60	225	220	205
100	−200	−100	−70	−30

calculated as approximately 61 billion Btu per year. If a fuel cost of 40 cents per million Btu is assumed, the annual fuel saving would amount to $24,600. If this be amortized at, say, 15 per cent, the present worth of fuel savings would be $164,000.

The average annual ambient temperature obtained by integration of Table 5 is approximately 50 F. At this ambient, the full-load capability increase is approximately 500 kw. If that figure is assumed to be representative of the increased plant capability, and if capability were valued at $150 per kilowatt, the worth of the increased capability would be $75,000.

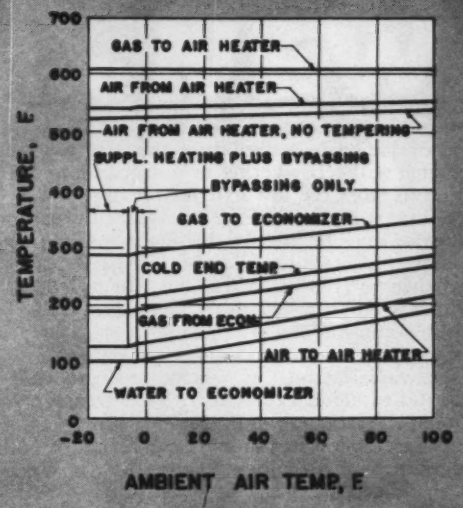
The economics of the installation are summarized as follows:

Present worth of fuel saving	$164,000
Value of capability	75,000
Total	$239,000
Total cost of installation (differential)	150,000
Difference in favor of economizer	$ 89,000
Return on extra investment	59 per cent

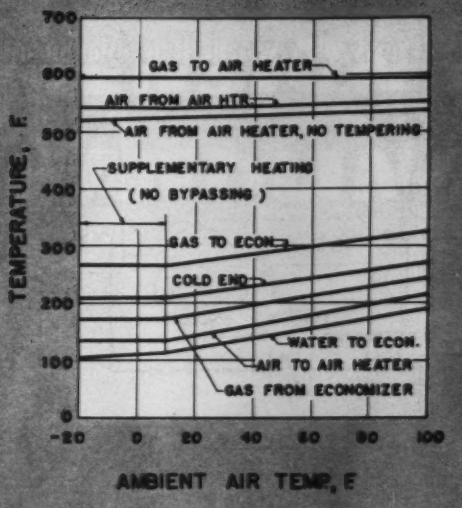
For the conditions assumed in this study, there appears to be an economic advantage in the economizer installation, although data for central-station plants operating at stack temperatures as low as those pertinent to this study are meager.

Low-Level Economizer as a Feedwater Heater

A second study was made in which a low-level economizer was substituted for the intermediate-pressure feedwater heater, Fig. 7. The low-level economizer was selected on the basis of matching the feedwater quantity at



(c) 2/4 load.



(d) 1/4 load.

Table 5 Hours Operation per Year

Ambient temp, deg F	Load on station 4/4	3/4	2/4	1/4
—20	40	20	10	10
0	160	80	40	40
20	700	300	150	50
40	800	500	200	260
60	1500	1000	200	100
80	1200	440	200	200
100	200	100	160	100
	4600	2440	960	760

Table 6 Heat Rate Comparison for 1½-in.-Hg-abs Back-Pressure at an Ambient-Air Temperature of 80 deg F

Load	Conventional cycle, Btu/kwhr	Low-level-economizer cycle, Btu/kwhr	Reduction, Btu/kwhr
4/4	10,258	10,154	104
3/4	10,439	10,315	124
2/4	11,210	11,024	186
1/4	13,704	13,336	368

full load, at an ambient-air temperature of 80 F. There was a small increase in the quantity of steam bled to the deaerator at full load.

In recalculating the heat balance for each of the four load conditions, it was assumed that the extra generation corresponding to the steam quantity saved by not extracting for the intermediate-pressure feedwater heater could be realized. Full account was taken of variation in extraction pressures and evaporator vapor quantities. The decrease in theoretical draft was considered as well as the variation in induced-draft fan power occasioned by the resistance of the low-level economizer. The boiler-feed-pump work was corrected for variation in feedwater quantity. The results of the heat-balance modification are summarized in Table 6, extraction for steam tempering coils having been provided in all cases.

The improvement in heat rate is greater at light loads than at heavy loads, because the steam which would have otherwise been extracted for feedwater heating became available for producing more electrical output.

At all loads except full load, the energy available due to heat transfer was so great that sizable reductions in extraction-flow quantities were found. At ¼ load, heat transfer in the economizer was so great as to permit bypassing of the high-pressure heater.

Economizer Construction. The low-level economizer selected for this service would be of cast iron, with integra fins. The installation would comprise two units of 1380 tubes each to be fitted into a space 17 ft high, 10 ft deep, and 23 ft wide. The operating weight of the economizer would be 926,000 lb, and would afford a heating surface of 100,300 sq ft. The estimated erection time would be 4710 man-hours. The cost of the complete installation is estimated at $300,000.

If an hourly loading schedule similar to that shown in Table 5 is assumed, the annual energy saving, as fuel, amounts to more than 86 billion Btu. At 40 cents per million Btu, this amounts to a saving of about $34,500. Amortized at 15 per cent, this is equivalent to a present worth of $230,000.

At each load there is an increase in capability due to the fact that more steam is expanded to condenser conditions. At full load this increase in capability amounts to 905 kw. The low-level economizer, complete with foundations, washing system, additional induced-draft-fan, and motor capacity and miscellaneous piping could be installed for about $300,000. The intermediate-pressure feedwater heater, which is to be replaced by the low-level economizer, would be worth about $25,000 installed.

The economics of the replacement are thus shown to be:

Present worth of fuel saving	$230,000
Capability increase @ $150 per kw	135,750
Total	$365,750
Net cost of economizer	$275,000
Return on extra investment	33 per cent

Time did not permit an investigation of the replacement of the intermediate-pressure feedwater heater by a low-level economizer over a wide range of ambient temperatures. It is to be expected that poorer heat rates will be encountered as the ambient-air temperature decreases, regardless of the method of feedwater heating.

The Low Level Economizer

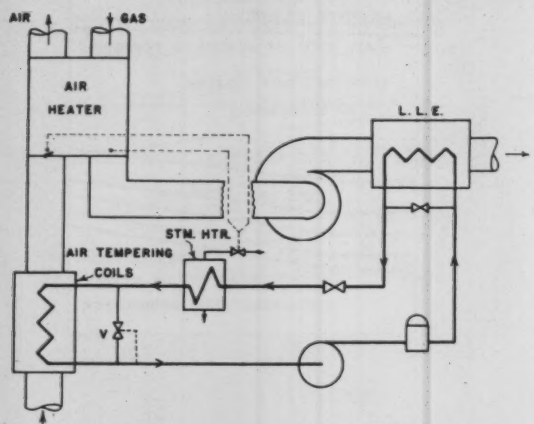


Fig. 6 The control scheme for economizer protection embodies two features — an automatic temperature-controlled by-pass valve and a supplementary steam heater. The supplementary-heater steam-inlet valve opens whenever the arithmetic average of the regenerative heater air-inlet and (uncorrected) gas-outlet temperatures reaches 210 F.

As has been pointed out, the investigation compared a cycle involving a low-level economizer used for feedwater heating with one containing a conventional extraction-steam feedwater heater: in both cases, a high-sulfur fuel requiring some form of air tempering was assumed. If a fuel was used which did not require air tempering, the gas weights involved would dictate a different economizer surface. In such a case, the heat-rate reductions would certainly be different and, the authors suggest, somewhat lower than those obtained for the case studied.

Discussion

The low-level economizer holds considerable potential as a device for recovering thermal energy that might otherwise have been wasted. How that energy is utilized is of prime importance. The low-level economizer must therefore be judged in terms of the effect it will produce in the over-all system.

Throughout this analysis it has been assumed that the flues downstream of the economizer, the stack breeching, and the stack are capable of withstanding the deleterious effects of corrosion. Only meager data are available on installations of this size and duty, and only time will tell whether or not operating difficulties will result from the low exit temperatures.

As operating experience is gained, still further economies may be effected by installing the low-level economizer adjacent to the air heater. The dust collector could then be reduced in size and cost and the induced-draft fan would handle a lower volume rate of flow of gas with an accompanying saving in power comsumption.

In the case where the low-level economizer was used for feedwater heating, it was pointed out that poorer heat rates would be expected with a decrease in ambient-air temperatures. In the case in which a low-level economizer and water-to-air, heat-exchange coils were used in lieu of steam-tempering coils, it was shown, Fig. 4, that better heat rates are to be expected with a decrease in ambient-air temperatures. This circumstance indicates that there may be considerable advantage in an installation which would be arranged to provide for both feedwater heating and for air tempering. At low ambients, most of the energy transferred from the hot gases in the low-level economizer would be used for air tempering, whereas, at high ambients, the principal use of the low-level economizer would be for feedwater heating. Such an arrangement would, of course, require more extensive apparatus and may not be justifiable from an economic point of view. The industry could well benefit from investigations in this direction.

Conclusions

For the particular cycle investigated in this study:

1 As a replacement for conventional steam-tempering coils, the low-level economizer shows greatest promise at low ambient temperatures and at part-load operation. When the ambient temperature approaches that corresponding to the air-heater cold-end temperature requirement, the value of the economizer decreases.

2 As a replacement for the intermediate-pressure feedwater heater, the low-level economizer shows significant potential savings in both operating cost and in increased capability of the turbine. The contribution of the economizer is greater at higher ambient temperatures.

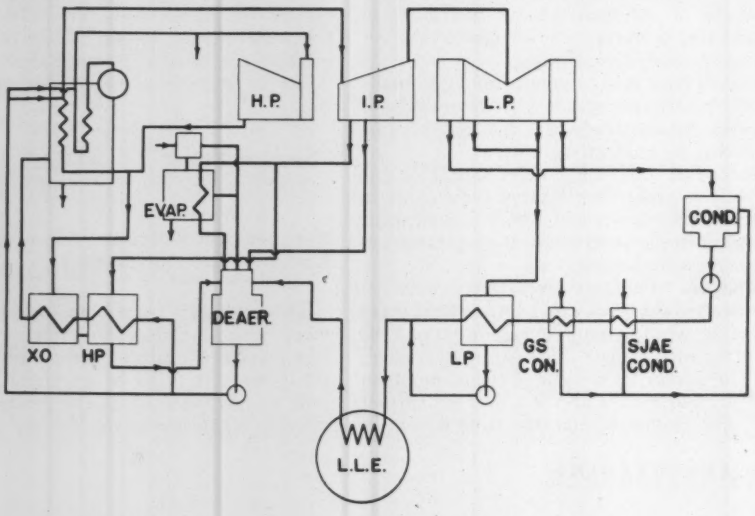


Fig. 7 Diagram of the cycle in which a low-level economizer was substituted for the intermediate-pressure feedwater heater.

The NEW DIMENSION in MATERIALS HANDLING

Courtesy B. F. Goodrich, Akron, Ohio

A materials-handling engineer discusses flow of materials, the over-all task of getting the product to the consumer

By C. William Drake, President, Lehigh Warehouse and Transportation Company, Newark, N. J.

It has become a cliché at engineering or management meetings to talk about "the revolution in materials handling." Actually, what is generally meant is that new hardware has become available—new electronically controlled fork-lift trucks, new automatic conveyer systems, or new computer-controlled distribution centers. The speakers are talking mainly about automation and electronic data processing.

To a practical warehouseman, the son of a practical warehouseman, it seems that an aspect of materials-handling engineering has been left out that has more practical implications than any of the mechanical or electronic innovations—as significant as they are. The time has come for the materials-handling engineer to decide once and for all whether the scope of his contribution is to be defined in terms of new gadgets, or whether he is to play a more creative role in the management of the business he serves. This is a very general observation and one which requires elaboration.

Contributed by the Materials Handling Division and presented at the Annual Meeting, Atlantic City, N. J., November 20–December 4, 1959, of The American Society of Mechanical Engineers. Condensed from Paper No. 59—A-325, originally entitled "Creative Engineering: The New Dimension in Materials Handling."

The Total Distribution Concept

The materials-handling engineer who wants to make a real contribution has to look not at the cost of each specific materials-handling operation, but rather at the total cost of getting a product from the end of the assembly line to the ultimate consumer.

Within the framework of this total approach to distribution costs and efficiency, the materials-handling engineer becomes involved not in the engineering of a specific piece of equipment or a specific materials-handling operation, but rather in the total distribution operation, and in the relation of distribution to purchasing, production, sales, accounting, and the other functions of the business. He becomes an important member of the management team who is concerned with the over-all success of the business, as measured by profits and by growth.

Courtesy Jervis B. Webb Company, Detroit, Mich.

When the materials-handling engineer fills this role, his contribution is not the decision of whether a fork-lift truck is better than a conveyer for a particular function or whether an electronically controlled conveyer system is economic, or one warehouse layout more efficient than another. He is involved not with catalogs or equipment salesmen, or even computer-programming or operations-research teams. Instead, he has to apply what in too many cases is a rusted capability—rusted from disuse. He has to draw on pure creativity in the organization and integration of materials-handling operations.

To be more specific, the total problem and the total equipment and techniques should be considered and a total solution produced that amounts to the most efficient and the least costly way of getting the job done.

Everyday Problems

To bring these points down to the kind of practical problems dealt with every day in materials handling, take, for example, the typical decisions involved in the distribution of a product that is packed in cans.

A few years ago an extremely efficient automatic case-packing machine was developed that packs cans in cases. Today this piece of highly automatic and expensive equipment is so standard—and this reflects the kind of materials-handling engineering that is only too common—that it is incorporated in many operations despite the fact that it is not economic and not efficient. In many bottling and canning operations, the specific conditions of uniformity, volume, and rate of utilization which are necessary if this equipment is to operate anywhere near theoretical efficiency do not exist.

While it is running, performance may be satisfactory if performance is measured by the number of cases per hour or day or man-hour. However, looking at the total cost of the operation, in many cases there are more efficient ways of getting these products from the production line to the consumer. Usually these do not involve the use of this kind of highly automatic, inflexible, and expensive machinery.

Another canning operation and materials-handling problem is characteristic of the chemical industry. One of the major chemical companies manufactures in Texas. The chemicals formerly were drummed in Texas and shipped to the eastern seaboard, where the drums were then distributed to local public canneries and canned for consumer distribution. Either that, or they were shipped in tank cars from Texas to various points in the northeast, and the shipments broken down there for distribution either by tank trailer or in drums or in cans.

Materials-handling engineers had worked long and hard to perfect each specific handling function, and there probably wasn't a penny or an hour to be saved by doing any one function differently. Apparently, the materials-handling engineers felt that this was the end of their responsibility.

Yet the cost of returning the empty drums or tank cars from the east coast to Texas was greater than the cost of the chemicals shipped in the drums. What is more, the cost of unloading and reloading the chemicals at each point in the operation was probably greater than the total cost of transportation from Texas to the ultimate consumer.

Like many materials-handling problems, this had nothing to do with specific materials-handling machinery or equipment. It was an over-all management problem, in materials-handling terms.

Bulk chemicals are now loaded on a tanker in Texas and brought to a tank farm in Bayonne, N. J., where they are piped from the ship into tanks. Supplies are drawn from the tanks as needed and fed to a canning line, located in one of the company warehouses. Empty tanks are stored adjacent to the canning line, and the filled cans are held only briefly until they are ready for distribution to the ultimate consumer. Tank trailers can also be serviced for a short run from the tank farm to the customer and back.

Management and the materials-handling engineer have worked out a solution to a materials-handling problem that involves a major reorganization of a total distribution operation. Economy and customer service have been improved without the introduction of any complex or costly equipment. In addition, the savings and improvements effected are far greater than any which could be accomplished within the framework of any expenditures on equipment, either mechanical or electronic.

As long as the materials-handling engineer thinks in terms of better ways of handling cans, he is divorcing himself from the rest of the distribution team, of which he must become an active and participating member if he is to play a real role in serving management.

Shipping cans from the manufacturer to the canning operation is another expensive operation because a lot of air and metal are being shipped, costly storage space is

required, and in shipping the finished product, air and metal are still being shipped.

Recently a materials-handling engineer, and incidentally a man who pioneered in the introduction of some excellent canning machinery and materials-handling equipment, came up with an entirely new plastic-coating paper that is stronger and more resistant. Round paper containers made of it by American Seal-Kap Corporation can be collapsed and shipped in the collapsed form. A simple machine reconstitutes them so that they can be filled and sealed.

Aside from savings in container costs and in materials-handling costs, the paper container can be inexpensively printed to produce a much more attractive package, again at a much lower cost. Containerization on a broader scale invites the materials-handling engineer to take a new look at the packaging and distribution of his company's products—not in terms of a piece of equipment, a technique, or a layout, but with a view to providing the greatest service to the customer at the lowest cost to the company.

Warehousing Examples

Two examples from the field of warehousing will illustrate the basic nature of the decisions in which the creative materials-handling engineer participates.

A drug company that manufactures in the middle west had decided that in order to provide its customers with goods as rapidly and cheaply as the competitors, it was necessary to establish regional warehouses in New York, Atlanta, San Francisco, and Fort Worth. However, when more variables were taken into account, the warehouse decision was questionable. At the suggestion of American Airlines, the decision was reviewed in terms of the Fort Worth warehousing operation, with a comparison of what these costs would be if air transportation were used. The company found that air transportation would give them the same service in the five-state area that they were presently getting from the warehouse. A 10-day sampling was made of the costs via the warehouse and via air transportation from the factory.

In order to supply the warehouse, full-truckload shipments were made from the factory to the warehouse, where bulk was broken and goods were forwarded to the ultimate consumer. The transportation for this 10-day sampling via the warehouse was $1397 and for shipping goods directly from the factory to the consumer $1859.

Warehouse and handling costs were reduced considerably from $1215 to $729. By consolidating the inventory at the factory, only one warehouse and handling charge was made. By reducing the inventories, obsolescence was cut from 2 per cent of sales to 1 per cent of sales, or from $1144 to $572. Eliminating state, county, and city taxes for the warehouse, and some insurance savings, made the cost for these items via the warehouse $496, compared to $258 for air transportation. By reducing the inventory, the financing charges for this 10-day period were reduced from $191 to $119. Although a portion of the inventory was pulled from the warehouse to the factory, no additional warehousing facilities were required and the elimination of the complete rent for the warehouse, $1163, was saved. Because of the more efficient operation at the factory, salary elimination came to $648 for the sampling period.

The total physical distribution for this sampling period when marketing via the warehouse was $6254 and with direct operation it was only $3537.

After the audit, this company closed the Fort Worth warehouse. Similar studies of the Atlanta, Boston, New York, and San Francisco warehouses determined that only the San Francisco warehouse was more profitable than direct shipment and the other warehouses were closed.

This detail is presented not as a brief for air freight, but because it illustrates the importance of considering the broader problems involved in any distribution decision.

Function of the Public Warehouse

Another similar set of variables is found in comparing all the costs of building and operating a company warehouse with those where public warehousing facilities are used.

In many cases companies would save money and improve service if they were to consider the range of services available from a strategically located public warehouse and the net costs of those services to the company. How many companies consider management time as a warehousing cost? How many engineers give adequate consideration to problems of peaks and troughs in the use of warehouse equipment when they are working on a new warehouse project for their company? Is adequate consideration given to alternative uses of the capital involved for new product and new market development? The use of public warehouses becomes increasingly challenging if they expand their range of services to include bottling, canning, and other types of packaging as well as an increased range of paperwork functions.

The materials-handling engineer should broaden his horizons and emancipate his thinking from the conventional preoccupation with equipment and layout in the terms that have been discussed.

Contribution of Creative Engineering

These examples suggest the general framework within which the creative engineer makes his contribution:

1 In terms of the requirements of the business and the total range of available techniques, he looks at the over-all problem of getting products from the assembly line to the customer.

2 Creative engineering seeks solutions in terms of over-all concepts, whereby the flow of materials is organized to reduce materials handling to a minimum and eliminate as many operations and functions as possible. It is no quibble to suggest that this approach is quite different from one which emphasizes performing each function as efficiently as possible, because it is perfectly possible to perform each function at optimum efficiency and still have a total operation that is wasteful and inefficient. When you are measuring efficiency, the whole does not equal the sum of the parts.

3 Transportation costs, the location of packaging operations, the total costs of central distribution versus regional warehousing, and the use of company-owned or public warehousing facilities and similar considerations are as much a part of the concept as hardware.

4 In many instances the availability of new materials-handling techniques invites fundamental re-examination of the organization of business operations with a view to a totally new approach to the materials-handling problem within the framework of which equipment decisions can be made. To quote a phrase that deserves more attention than it has received from materials-handling engineers, "*Ideas must precede hardware!*"

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD

Geothermal Power

GEOTHERMAL power, already in use in Italy and New Zealand, is to be given a test in this country with a 12,500-kw plant being installed by Pacific Gas & Electric Company.

Steam fumaroles in the vicinity of Big Sulphur Creek on a 3200-acre tract, inaccurately called The Geysers, in Sonoma and Lake Counties, Calif., will be the source of steam. The plant is described in an ASCE paper by Albert W. Bruce, Mem. ASME, and Ben C. Albritton.[1]

An adequate supply of steam for the economic life of the plant is present, and a steam-purchase agreement has been signed with Thermal Power Company and Magma Power Company which have drilled wells in the area to a depth of 523–1404 ft with the steam being produced at 500–700 ft. Additional facilities will be installed by PG & E when Magma and Thermal have developed the necessary steam supply.

Three wells are to be used which have a combined steam flow of 219,000 lb per hr and an enthalpy range of 1199 to 1207 Btu per lb. Additional wells will be drilled in order to provide sufficient steam for the first unit, which will require about 250,000 lb per hr. Wellhead pressures will be about 115 psig when turbine-inlet pressure is 100 psig.

The principal differences between the usual modern power plant and a geothermal plant are: (*a*) There is no boiler, so steam condensate is not recycled but is used for cooling-water make-up; (*b*) the steam pressures are lower; and (*c*) the steam has much larger quantities of noncondensable gases which must be removed from the condensate to maintain the vacuum.

A characteristic of the flow from a steam well is that the pressure drops with an increase in flow. Therefore there is a point at which the most power can be obtained with a combination of flow and pressure. It was decided for the first unit that a pressure of 100 psig would be used.

As it is not necessary to return the steam condensate, it was decided to use the less expensive barometric condenser wherein the condensing steam and cooling water mix. The mixture falls down a barometric leg into a hotwell and is then pumped to a cooling tower where it is cooled by evaporation.

A very important feature of the cooling cycle is that a lesser amount of water is lost by evaporation than is supplied by the condensed steam, which means that no external make-up is required except to fill the cooling system initially. The amount that will overflow from the cooling tower is 12 to 40 per cent of the steam condensate depending on the atmospheric conditions. The greater amount is obtained during the cooler periods of the day or season.

The noncondensable gases in the steam require a much greater capacity gas-ejecting equipment than conventional units. Because of its lower cost, it was decided to use steam-jet equipment instead of mechanical gas pumps.

The steam, as it comes from the well, contains solids which must be removed to prevent wear on the turbine blades. As a part of the contract, the steam suppliers are required to remove all the particulate matter that can be separated by the best commercial equipment available.

The construction of the building to house the plant ran into some interesting foundation problems since the soil temperature 55 ft below the surface is 170 F, and it is possible that there is chemical reactivity between the soil and ground water with the concrete.

Corrosion tests have indicated that stainless steel could be used for the barometric condensers, gas ejectors, and associated piping. All parts of the circulating-water pump, condensers, and gas ejectors that will be in contact with the water will be made of Type 316 stainless steel.

The turbine for the plant is to be designed for 100-psig and 348-F inlet steam conditions and a back pressure of 4 in. Hg abs. A 12,500-kw turbine-generator unit was available which had been installed in 1924 as Unit No. 2, in the PG & E's Sacramento Power Plant. The turbine is a General Electric Company 9-stage, 1800-rpm, single-casing, condensing turbine, designed for inlet steam conditions of 175 psig with 100-F superheat and $1^1/_2$-in-Hg-abs exhaust pressure.

The turbine will be modified by opening up the steam passages. The control valves will be replaced by two butterfly valves, 6 and 10 in., and the first three stages

Steam fumaroles will be tapped to generate electricity in California. Since there is no boiler, steam condensate is not recycled. Steam will be brought from the wells by the pipeline. Wellhead steam pressures will be about 115 psig when turbine-inlet pressure is 100 psig.

[1] "Power From Geothermal Steam at the Geysers Power Plant," Journal of the Power Division, Proceedings of the American Society of Civil Engineers, December, 1959, pp. 23–45.

will be removed. The remaining six diaphragms will be replaced because it is believed the copper brazing, used in the original construction, would deteriorate from the hydrogen sulfide in the steam. The 8th and 9th-stage buckets will be changed to increase the flow through them, and will be constructed of 11–13 per cent chrome steel. The diaphragms of the 8th and 9th stages will also be enlarged to permit more steam flow. The monel buckets now installed in the 4th to 7th stages will be retained as a protection against mercury. None has been found in the steam, but there are mercury mines several miles away.

It is expected that there will be fine mineral matter in the steam, which might cause the stem of the turbine throttle valve to stick. For this reason, an emergency stop valve of the swing check type will be installed after the throttle valve. Simultaneous tripping of the two valves will insure positive stopping of the steam flow.

The electrical energy produced at The Geysers Power Plant will be fed into the PG & E system over a new 60-kv transmission tap which will tie into the existing 60-kv circuits approximately 10 miles from the plant. The 34,000-kva capacity of the tap will be adequate for another comparable unit at this site.

The plant is being designed so it can be operated automatically without attendance. When an operating condition occurs that will endanger the unit, it will be shut down and an alarm signal sent to the attended Fulton Substation. Other abnormal operating conditions that will not endanger the unit immediately will be transmitted by another alarm signal to Fulton Substation and will alert the operator so that a trouble man in the area can be dispatched to the plant to investigate.

An operating condition that is serious enough to trip the unit requires investigation at the plant before the unit is restarted. For this reason, and because of the much greater cost of control equipment to automatically start a unit, manual control of starting is planned.

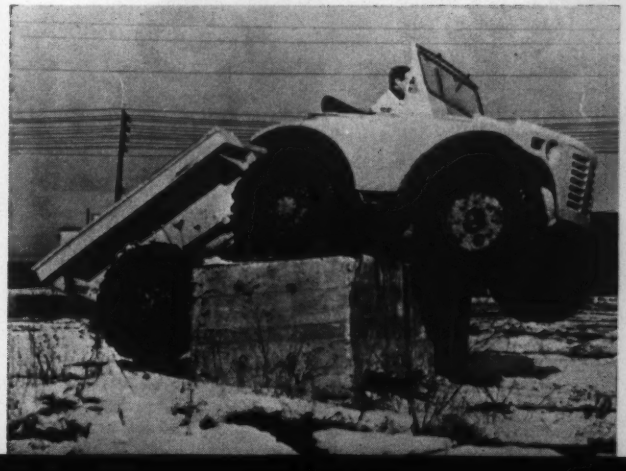
Wall-Climbing Truck

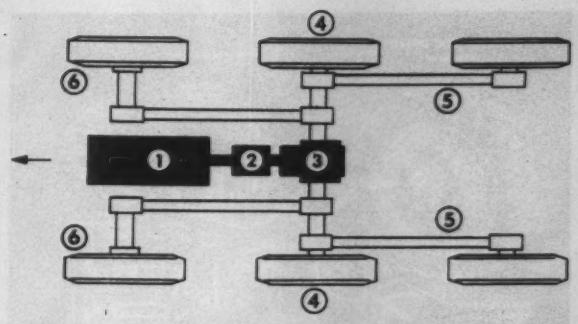
A ROUGH-TERRAIN truck that bends in the middle and is capable of climbing over a 3-ft-high 3-ft-thick wall in 15 sec was recently demonstrated by Clark Equipment Company's Industrial Truck Division.

Called the Flex-Trac, the six-wheeled truck designed by the Swiss firm, E. Meili, will traverse a 45-deg slide slope, "swim" across rivers, drive through mud, snow, sand, or marshland, and speed 56 mph over highways.

A unique articulated construction permits any one of the three pairs of wheels—all of which are drive wheels—

Unique articulated construction permits a wall-climbing truck to negotiate 3-ft-high concrete walls. Designed in Switzerland, any one of the three pair of wheels—all of which are drive wheels—can be hydraulically raised off the ground so the vehicle can become "swaybacked."





Axle and frame assembly of Flex-Trac: Motor 1, transmission 2, and axle drive with differential lock 3. Front and rear wheels 6 and 5, pivoting on guide arms, and driven by roller chains.

to be raised hydraulically off the ground so the vehicle can assume either a "swayback" or an "arched-back "position.

When the main hydraulic control valve is in "float" position, the truck articulates freely, permitting all six wheels to maintain contact with the terrain.

Unusual traction, braking, and steering features permit all six wheels to turn together regardless of traction conditions at individual wheels. Braking can be applied to all wheels simultaneously or to the left or right wheels to permit steering in a manner similar to that used with Army tanks. The truck can pivot in its own length by raising front and rear wheels and braking a middle wheel.

The two center wheels are mounted on an axle with a conventional differential at the center. Arms at both ends, which are actually roller-chain housings, pivot about the axis.

One arm extends forward and one rearward. Front and rear wheels are mounted on these arms. Thus each front and rear wheel may pivot up or down from the center axle.

In normal driving, left wheels rotate together and right wheels rotate together. For example, the left center wheel is driven directly by the left axle shaft and the left front and rear wheels are driven indirectly from the left axle shaft through chains and sprockets. Right wheels are driven in the same manner from the right axle shaft. The differential on the center axle can be locked out so that all six wheels rotate together.

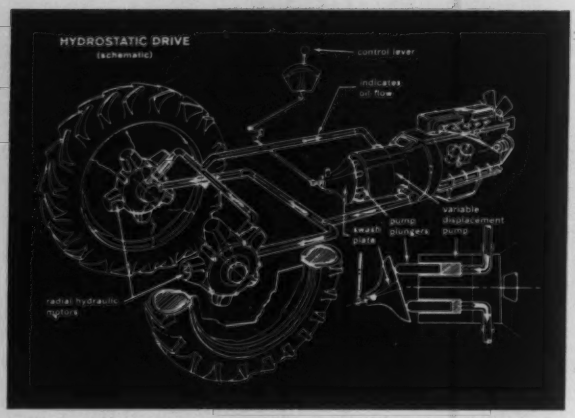
The body is divided into two parts which are supported independently of the truck frame by hydraulic cylinders, one connected to each of the front and rear wheels. In addition, two hydraulic cylinders cause articulation of the basic frame.

For amphibious operations, two removable propellers are attached and engaged with a power take-off unit on the transmission. Direction is then controlled by front-wheel steering.

Drive train of the Flex-Trac consists of a standard 6-cyl automobile engine, a foot-operated clutch, and two gear boxes which provide 13 forward speeds and four reverse speeds.

Clark is evaluating two Flex-Trac models at its Battle Creek testing grounds. One is of 1-ton capacity, weighs 3300 lb, and has an over-all wheelbase of 86.5 in. The other is of 2-ton capacity, weighs 7100 lb, and has an over-all wheelbase of 112 in.

Tests will determine suitability of the units for construction work, logging, mining, mineral exploration, and similar rough-terrain applications.



Hydraulic Transmission

CLUTCH and brake pedals, gear-shift lever, and the entire complex of gears, shafts, and splines that normally send power from engine to driving wheels have been eliminated in a research tractor built by International Harvester.

There's no rear axle, either—only a yoke that serves as a structural member. The big, hollow, main-frame casting that ordinarily houses transmission and differential has also been eliminated.

Once the engine is started, a single lever on a quadrant near the steering wheel starts forward or reverse motion and controls speed over an infinitely variable range without clutch or gears. The change from forward to reverse motion requires a simple, corresponding movement of the control lever. In neutral, the lever stops the tractor as positively as any band or shoe brake.

This research tractor has been developed by the Engineering Research group, under the direction of A. E. W. Johnson, vice-president of engineering, and C. H. Meile, Assoc. Mem. ASME, chief engineer, Engineering Research. A hydrostatic transmission system is used which depends on oil at high pressure to transmit power by action on a moving piston. Although experimental as far as tractors are concerned, hydraulic transmissions have been known for at least 30 years and are in commercial use on ships, winches, ready-mix concrete trucks, and in other heavy-machinery applications.

The system devised for evaluation has three major parts: A pair of radial, hydraulic motors—one in each driving wheel—and a variable-displacement pump which furnishes pressure energy to the system. The pump is coupled directly to the tractor engine. Piston action in the motors resembles that of a radial aircraft engine, with oil pressure replacing combustion and expansion of gases to move the pistons. The pistons act on an eccentric which serves as a crankshaft, converting hydraulic pressure to torque to turn the wheels.

Key to the system is the variable-displacement pump in which the slightest plunger stroke is instantly converted by the motors to torque at the driving wheels. By changing the angle of a swashplate in the pump, the control lever can lengthen or shorten the stroke of nine plungers, thus increasing or decreasing speed of the tractor within its maximum range of about 11 mph.

With the control lever in the vertical position—neutral—on the quadrant, the swashplate stops action of the plungers. Deprived of pressure energy, the oil in the system serves as a positive brake on the wheels. Since each driving wheel is turned by its own motor it is also possible, by shutting off pressure to one wheel, to divert all of it to the other. In effect, this brakes one wheel and increases torque at the other for very short turns, providing higher maneuverability.

Since it is incompressible, freely flowing oil, used as the driving medium between pump and wheel motors, makes the connection between tractor engine and driving wheels as positive as if it were solid-steel shafts and gears. Thus the tractor's response to its transmission controls is immediate and solid. This marks a sharp difference between hydrostatic drives and hydrokinetic, the kind commonly used in automobiles, which have slippage between engine and driving wheels, and require engine speed-up before the drive can operate.

A load-governing device has also been designed into the system which automatically reduces forward speed to increase torque as required when a hard spot is hit or in ascending a slope. The device then returns the system to its previous rate of travel when the added torque is no longer needed.

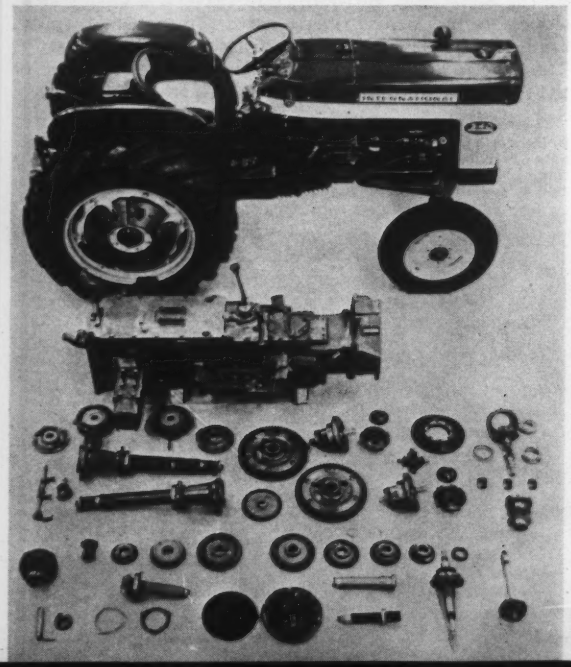
By reversing the flow of oil in the system, almost instantaneous changes are possible between forward and reverse.

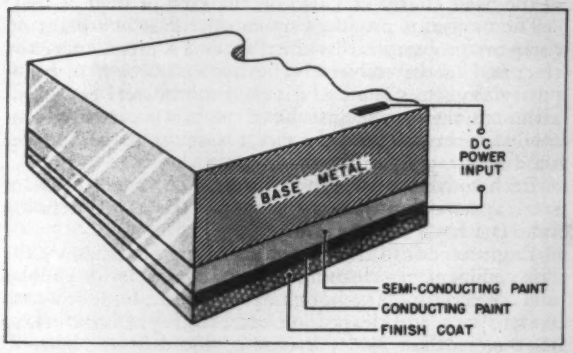
Some important problems which will have to be solved before the hydraulic transmission can meet the competition of conventional gear drives are improved fuel economy and a reduction in the high cost of components. Such components as the pumps and hydraulic motors will have to be mass-produced before the cost problem can be solved.

Machine-Tool Recovery

IN 1959 the machine-tool industry made a substantial recovery from the sharp recession experienced in 1958. Net new orders of metal-cutting-type machine tools, according to *Machine Tool Progress*, published by the National Machine Tool Builders' Association, totaled $509 million as compared to $281.4 million in 1958. The 1959 figure was slightly below the 1957 figure of $519.75 million and below the post-Korea average. In both 1956 and 1955, new orders exceeded $920 million.

The Hydrostatic transmission replaces gears, axle, brakes, clutch, and the main-frame casting that held them. All the parts arranged on the floor beside the International 340 Utility Tractor are unnecessary.





Layers of semiconducting paint and colloidal copper comprise the electrolyte and anode in OTAC's anticorrosion coating

Jeep Protected Against Corrosion

To COMBAT atmospheric corrosion on military vehicles in inactive storage, the Army's Ordnance Tank-Automotive Command, Centerline, Mich., has experimentally installed a cathodic protection system on a jeep.

Conventional paint-spraying equipment is used to apply a semiconducting paint as the electrolyte and a conductive layer of colloidal copper as the anode before the finish coat is added. Low-level d-c is used to make the protected vehicle cathodic in respect to the copper.

Electric power is supplied through a main ground terminal on the vehicle chassis, and to individual printed-circuit electrodes on the copper anode. Power requirements are less than 1 volt at a total output of 0.4 watts.

According to the article describing the system in the March 31, 1960, issue of *Machine Design* by David K. Wilburn, a physicist with OTAC, the test vehicle is scheduled to get a solar-cell system which will adequately meet daytime power demands.

Plutonium-Alloy Rolling Mill

A REMOTELY controlled rolling mill for plutonium alloys has been designed to operate within an air-tight steel enclosure vessel by Loma Machine Manufacturing Company, Inc., of New York, for installation at the Hanford Works. It will be used to produce fuel elements for the Plutonium Recycle Test Reactor in a variety of shapes and configurations. The reactor is part of a long-range experimental program expected to lead to the use of plutonium as a fuel.

Plutonium is an alpha-emitter of high toxicity and has to be handled with extreme care. The greatest danger is the inhalation of plutonium-bearing dust since it is estimated that a man will excrete only one half his body burden of plutonium in approximately 100 years.

Because plutonium readily oxidizes in air and there is a danger from spontaneous combustion, it is necessary to process the metal in an inert atmosphere of argon. The four sections of the mill's gastight hood will be flanged onto the housings in cruciform shape, with two sections containing the run-in and run-out tables, as well as an electric resistance furnace, and the other two sections containing the mill-drive spindles and the roll-removal and storage ways. The entire hood virtually is a large vacuum vessel which will be evacuated to a pressure of 1 micron Hg prior to the start of operation. It is then back-filled to atmospheric pressure with argon in order to obtain an atmosphere of acceptable purity. Rubber gloves attached to ports, with an extreme reach of about 24 in. and a working distance of about 18 in., will be used in operating the mill.

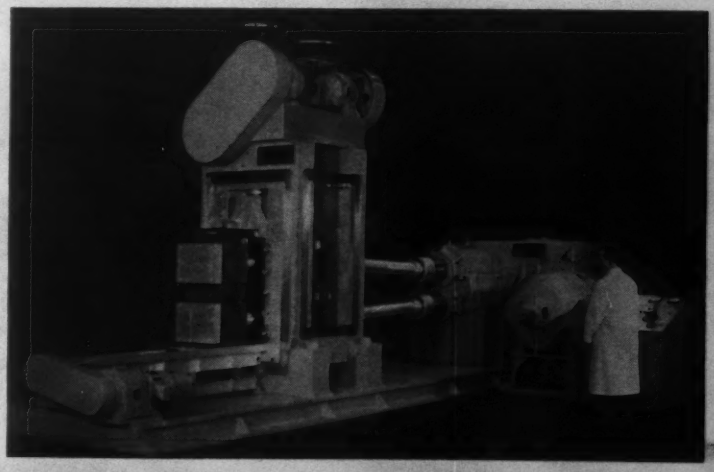
Since argon atoms are easily ionized and cause insulation breakdowns if electric motors are operated in an argon-filled atmosphere, both the main mill motor and auxiliary motors for screwdown and roll-changing drives are mounted outside the hood, to operate in air.

The new machine is a 20-in-wide 2-high/4-high combination rolling mill employing 3-in-diam work rolls and 14-in-diam backup rolls. An outstanding feature of the mill is its power-operated roll-change mechanism which facilitates removal and replacement of various types of rolls within the glove-box area. The roll-change mechanism not only accelerates change-over of rolls from 2-high to 4-high operation, and vice versa, but provides safe, remote-control handling of rolls assumed to be contaminated beyond tolerance once they enter the mill enclosure.

The use of interchangeable roll sets allows the mill to perform various processing functions which, in conventional practice, would call for a 2-high hot breakdown mill, a 2-high cold intermediate mill, a 4-high cold finishing mill, and a 2-high rod-rolling mill.

The roll-separating-force capacity is 800,000 lb at a speed of 100 fpm. The mill housings are of steel construction and the roll journals run in heavy-duty, super-precision cage-type needle roller bearings. The remote-control power screwdown system consists of two 5-hp gearmotors offering alternate speeds of $^1/_4$ and 4 ipm. An electromagnetic clutch connects the two screwdown motors when simultaneous adjustment of mill settings is required on both sides.

The mill is driven by a 100-hp General Electric Speed Variator set comprising a d-c mill motor, a motor-generator, an operator's console, and various control equipment. The drive offers constant horsepower characteristics from 42 to 24-fpm rolling speed and constant torque characteristics from 24-fpm to creeping speed.



A combination rolling mill for remotely controlled operation in a glove box with an argon atmosphere. The four sections of the mill's gastight hood will be flanged onto the housings in cruciform shape with two sections containing the run-in and run-out tables, as well as an electric-resistance furnace, and the other two sections containing the mill-drive spindles and the roll-removal and storage ways. It will produce plutonium fuel elements for use at the Hanford (Wash.) Works of the AEC.

"Instant" Steel

AN UNIDENTIFIED Midwestern company has merged the hot-blast cupola and oxygen converter to achieve a new steelmaking process that produces a heat of semi-finished steel every 40 min at $5 to $10 a ton cheaper than it could be purchased.

As described in the March, 1960, issue of *Steelways*, official publication of the American Iron and Steel Institute, scrap and pig iron are melted in hot-blast cupolas and the molten metal is refined into steel in oxygen converters.

Increased production of special-fastener steels, such as strapping, barrel hoops, and stitching wire, and more recently of hot and cold-rolled strip and galvanized strip made an assured supply of semifinished steel necessary.

The two giant cupolas—the largest in the world—resemble small blast furnaces. They are cylindrical in shape, about 80 ft high and 11 ft in diam. Raw materials for each cupola consist of approximately 78 per cent scrap and pig iron in about a 3-to-1 ratio, 16 per cent coke for fuel, 5 per cent limestone for forming slag to remove impurities, and 1 per cent fluorspar for keeping the slag fluid.

A system of gas locks permits charging of the cupola while maintaining full blast pressure. Burning gases pass through a dust-collecting system and preheat the hot blast of air that enters the cupola through water-cooled copper tuyeres in the bottom. Four blowers maintain the 1000-F blast at a pressure of about 8 psi.

Molten metal flows continuously from the cupolas into the 200-ton mixers that keep it hot. The rate of production in each cupola can be varied from 15 to 50 tons of metal an hour by changing the pressure and volume of the hot blast and charged materials.

Adjoining the cupolas are the two oxygen topblown converters, each 14 ft in diam and 25 ft high. They rest on trunnions and can be tilted in one direction to receive a charge and in the other direction to pour a heat of steel.

The basic charge in the oxygen converter is about 80 per cent molten metal from the cupolas and 20 per cent scrap. To this is added smaller amounts of limestone, fluorspar, mill scale, burnt lime, and ferromanganese, the precise amounts depending on the chemical analysis of the basic charge and also on the kind of steel desired.

The oxygen is produced by another firm in a plant on company property across the river and is piped under the river bed to the converters. About 2000 cu ft of high-purity oxygen is required for each ton of steel produced, although the precise amount of oxygen is carefully controlled to insure that the exact amount of carbon desired will remain in the steel.

Each converter can produce a heat of 50 to 60 tons of steel approximately every 40 min; the actual refining time is a little over 20 min.

Engineered into the new steelmaking facilities are the most efficient gas-cleaning systems available for cupolas and converters. The hot gases are cooled, scrubbed with water spray, and cleaned in electrostatic precipitators, so that more than 99.5 per cent of the dust is removed. Similarly, a water-clarification system and filter house return the water used in the steelmaking process in a cleaner condition than when it was pumped from the river.

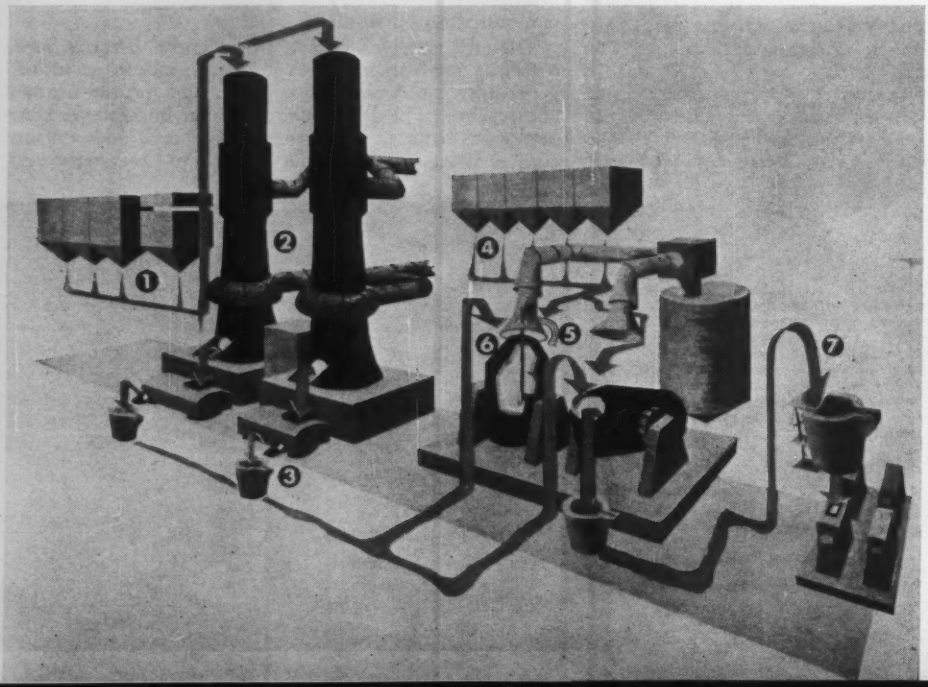
This modern cleaning equipment, costing more than a million dollars, was installed in the best interests of the surrounding community.

Moderate sized batches of good-quality steel permit new flexibility in tailor-making the product to customer needs. For an additional $5 million the company can later install a third cupola which will raise the plant's capacity from 450,000 to 675,000 ingot tons per yr.

Extrusion Cladding

A PROCESS that employs extrusion for cladding metals has been developed at Battelle Memorial Institute, Columbus, Ohio. The process is applicable to both simple and complex shapes. Much of the Battelle work has involved aluminum-clad steel. The process can also be used to clad aluminum on copper and nickel and alloys of these metals.

Three distinct advantages appear to be offered by the process: (*a*) It permits close dimensional control over the cladded product; (*b*) it permits a strong bond between the core and the cladding material; (*c*) the cladding does not have to be the same contour as the core. In addition, the process permits the cladding of many complex shapes which cannot be clad by standard meth-



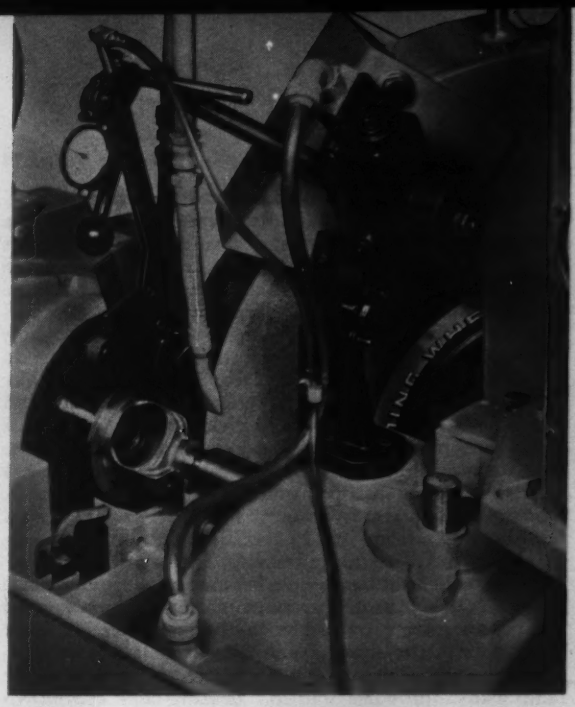
In the new steelmaking process: **1** Raw materials are automatically weighed and charged into the top of the cupolas **2** by automatic hoists. Molten metal flows continuously from these into mixers **3** that keep it hot. **4** It is then added to scrap (about 4-to-1 ratio) and with smaller amounts of limestone, fluorspar, mill scale, burnt lime, and ferromanganese comprises the charge. **5** After the charge is introduced and the converter **6** returns to an upright position, a water-cooled oxygen lance is lowered into it and high-purity oxygen blown onto the surface of the bath. **7** The refined steel is poured into a ladle and then into ingot molds.

ods. Conventionally, simple shapes like rounds and tubing are clad by "rolling" or "sinking" a tube of the cladding metal over the rod or tube serving as a core.

To clad by the extrusion process the core material is fed through a hollow mandrel converging upon a die. The mandrel is housed inside a chamber containing rams that are used to extrude the cladding material. The cladding material is forced through ports located in the chamber between the terminal end of the mandrel and the die. Thus the core and the cladding material pass through the die simultaneously. Both the core and the cladding are heated in the extrusion chamber. The process could be operated on a continuous basis.

Because the die governs the shape of the cladding, the cladding need not be the same shape as the core. A wide variety of cladded products has been produced, ranging from simple cladded rods to hollow core overlaid with cladded fins.

The nature of the process makes it possible to produce integral bonds, simple mechanical bonds, and sheathing effects, where an actual bond is not desired. The sheathing effect points up the possibility for metal cladding a core that has been coated with a nonmetallic material. If the nonmetallic selected were an electrical insulator, a transmission line could be produced with an outside metal casing that was resistant to corrosion and other destructive forces. Another possibility is the production of heat-exchanger tubes for use in corrosive atmospheres.



Two widely varying diameters and the adjacent faces are ground simultaneously on the Cincinnati Angular Wheel Slide Grinding Machine. Also shown is the flagging device (available in either manual or automatic) for axially locating work.

Ultrasonic Cleaning

An ultrasonic cleaning system, claimed to be more efficient for many applications than those using magnetostrictive or barium-titanate transducers, has been engineered by Branson Ultrasonic Corporation, Stamford, Conn. Based on a unique, sandwich-type transducer, the new Sonogen Z system is available in both high and medium-intensity versions. Standard tank capacities range from 2 to 75 gal, consuming 150 to 2000 watts.

The lead-zirconate-titanate transducer is designed to operate at 25 kc. Because it can convert larger amounts of power than barium-titanate transducers used with 40-kc installations, it may be operated as a full-wave system, thus doubling the effective power output per unit area. Doubled cleaning efficiencies are also possible.

The new lead-zirconate-titanate transducer removes the inability to operate continuously at temperatures above 160 F, and difficulty in making transducer repairs at a reasonable cost found with barium-titanate.

Grinding Machines

Shoulders and shafts are ground simultaneously, with critical dimensions, angles, and corner radii established at the same time in a line of grinding machines built by Cincinnati Milling's Grinding Machine Division.

The Filmatic semiautomatic angular wheel slide grinding machines, built in 6-in-radius × 10-in-long and 10-in-radius × 14-in-long sizes, are specifically designed to combine OD and shoulder grinding in a single, fast, automatic cycle. Typical applications include crankshafts, steering knuckles, gear blanks with hubs, and stepped shafts with critical flanges, tapers, and shoulders. Built to feed at either 30 or 45 deg, these machines make it easy to obtain a superior circular line finish instead of a crisscross finish.

Generally, workpieces having a long ground diameter compared to shoulder height are better suited to a 30-deg machine while jobs having shoulder height equaling or exceeding the diameter are better adapted to 45-deg wheel-feed machines.

Automatic behind-the-wheel profile truing provides fast, accurate grinding-wheel truing with provisions for two to ten passes with or without diamond advance on the last pass. It may be set to true after a predetermined number of pieces have been ground.

Angular wheel slide grinders are equipped with Cincinnati's exclusive self-adjusting Filmatic bearings. The grinding-wheel spindle rides on a wedge-shaped cushion of high-pressure oil created by the interaction of the spindle and bearing shoes.

Automatic grinding-wheel balancing is also standard on these machines. It provides a method to balance the wheel on the machine in seconds.

Operator convenience is an outstanding feature with the automatic infeed cycle. When the grinder is set for automatic operation, pressing the wheelhead-advance button initiates an automatic cycle that hydraulically clamps the table, rapidly advances the wheelhead, starts work rotation, grinds at fast feed rate, grinds at slow feed rate, tarries, rapidly returns the wheelhead, stops work rotation, and unclamps table.

Sizing adjustments as fine as 0.00005 in. on work diameter are possible because of Cincinnati's hydraulic-motor drive of the infeed screw. The all-V-belt headstock drive insures smooth work rotation for high-quality finishes.

As optional equipment the Cincinnati angular wheel slide grinder can be provided with automatic air-electric gage sizing with a cycle-time stabilizer which automatically corrects the grinding-time cycle to compensate for wheel wear. An automatic gap eliminator is offered to reduce time "cutting air" during infeed grinding cycle, and a simple, accurate flagging device, either manual or automatic, is available for axial location of work.

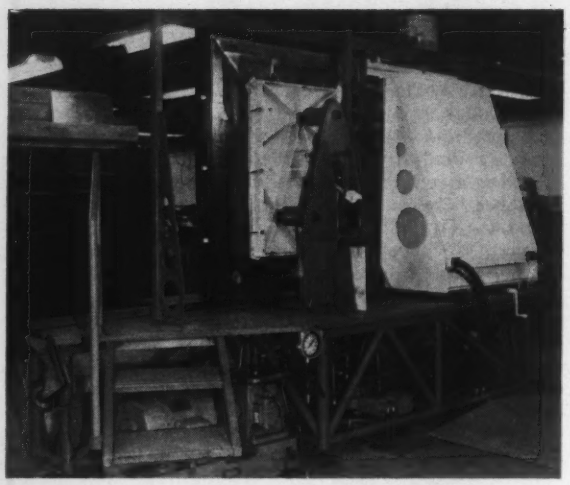
Radiant Brazing Process

ELECTRONICALLY CONTROLLED banks of radiant quartz lamps are used to braze stainless-steel honeycomb panels, in a process called Nortobraze, developed by Northrop Corporation, Hawthorne, Calif. Nortobraze completes the brazing cycle in minutes, and is expected to replace the present 3 to 12-hr furnace brazing methods.

An Air Force contract with the Manufacturing Methods Division of the Aeronautical Systems Center at Wright-Patterson Air Force Base, Dayton, Ohio, has been awarded for adopting the process to manufacture of advanced aircraft and space vehicles. This work will be done with automatic precision brazing machines. One such machine, capable of brazing moderate sized panels, has been in operation for nearly two years at Northrop's Norair Division. Brazing cycles on this machine range from 5 to 15 min, depending on the complexity of the panel being brazed.

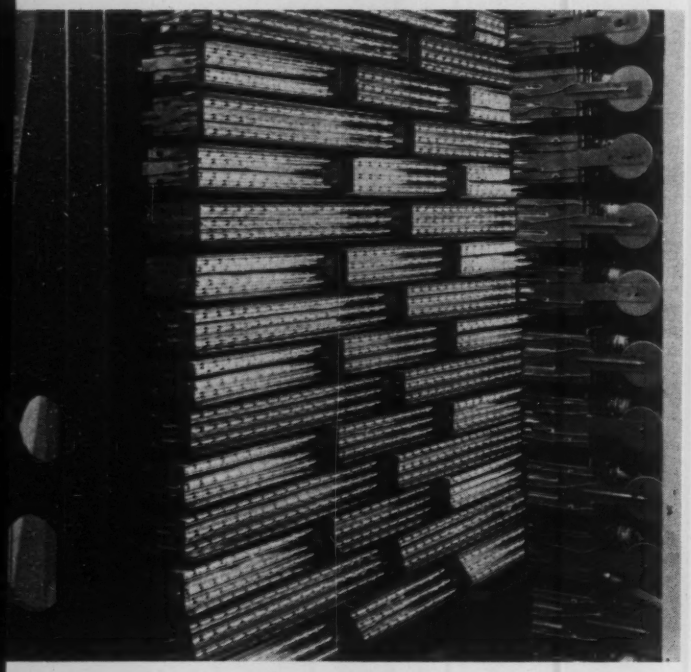
Radiant quartz lamps in the machine provide heat up to 6000 F. Automatic controls, an important part of the process, are provided with thermocouple feedback from inside the honeycomb panels during brazing. Electronically controlled temperature selectivity in the lamp banks provides uniform heating and cool-down throughout the panel, regardless of varying core thicknesses or solid-metal inclusions which have varying heat-sink rates. The brazing envelope is gastight and made of soft auto-body steel.

The automatic brazing machine consists of two major elements—opposing banks of radiant quartz lamps for brazing, and opposing dies which clamp the panel for the chill cycle. A hydraulically operated carriage riding single top and bottom rails holds the part in an upright position and automatically positions it between the lamp banks or the chill forms. The lamp banks have a total output of 200,000 watts per sq ft of honeycomb panel, although only about one-fourth of that amount is used for present brazing jobs. Maximum heat in the quartz lamps is 6000 F. The chill dies have channels for circulating cooling water, although normal heat radiation from the die mass is sufficient for most cooling operations.



A stainless-steel panel, in its airtight envelope, is being held in the chill position. The part has just moved from between the banks of radiant brazing lamps, **at right,** and is held between chill forms. The carriage frame supporting the enveloped part, **at center,** is covered with gold-fired shields. Their high reflectivity prevents overheating of the structure surrounding the brazed area during the brazing cycle.

Banks of radiant quartz lamps can be energized and controlled selectively for brazing various panel shapes and sizes



In addition to the stainless-steel family of metals, Nortobraze has been applied to titanium alloys and is adaptable to the more exotic metals in the columbium and molybdenum groups which are coming into use in the design of satellites and other interplanetary space vehicles.

750-Kv Test Line

A NEW extra-high-voltage test project will be undertaken jointly by American Electric Power Service Corporation and Westinghouse Electric Corporation. The test is in continuation of investigations begun by the two companies at Brilliant, Ohio, in 1946, when they built and operated the 500-kv Tidd test line. A 750-kv test transmission line will be constructed at Apple Grove, W. Va.

According to A. C. Monteith, Hon. Mem. ASME, vice-president and general manager of Westinghouse apparatus products group, the project will develop the experience and equipment needed to transmit larger and larger blocks of power economically.

Phillip Sporn, Hon. Mem. ASME, president of American Electric Power, said that as a result of the work on the Tidd test line, the AEP System was able to build and operate economical 345-kv lines. "We are hopeful that this new study will push forward the frontier, both technical and economic, of transmission voltages at higher levels up to 750 kv," he added.

Work on the project will start immediately with first tests scheduled for late 1960 or early 1961. The tests will continue for three to five years.

Several innovations in testing techniques will be made in the Apple Grove project. Three test lines will be built. Each will have a different conductor configuration. The lines will be energized simultaneously to measure radio-influence voltages and corona losses, permitting a comparison of test results under identical atmospheric conditions.

In addition, all conductors on all three test lines will continuously carry heating current to simulate actual operating conditions. Test results will be processed through automatic data-logging computers and recording instruments.

Other companies that are participating in the project and the equipment or materials which they are supplying include: Kaiser Aluminum & Chemical Corporation, conductors; Lapp Insulator Company, Inc., and Ohio Brass Company, insulators and hardware; Thomas & Betts Company, Inc., connectors; and the American Bridge Division of United States Steel Corporation, towers.

Sulfur Reduction in Bituminous Coals

SIGNIFICANT results leading toward the probable reduction of sulfur in bituminous coals have been achieved by Bituminous Coal Research, Inc., in fundamental research under cosponsorship of the electric utility and coal industries. The results of this project are expected to be of great financial significance not only to the utilities but to other industries which burn coal or use it as a raw material in the manufacture of other products.

A two-project program, its objective is to reduce atmospheric contaminants in flue gases. It is sponsored by the Association of Edison Illuminating Companies and Edison Electric Institute jointly representing investor-owned electric utility companies and BCR representing the coal industry.

One project consists of engineering evaluation and exploratory research on methods for control of atmospheric contaminants by removing sulfur dioxide from flue gases after the coal is burned. The other project attacks the problem by removing pyritic sulfur from coal before it is burned. Promising results were obtained on the latter project.

Working with five high-sulfur bituminous coals from different areas of the United States, BCR has been able to liberate a substantial amount of the pyritic sulfur from the coal material. It has been concluded that an effective process for reducing sulfur in bituminous coals is now possible, although further work must be carried out to develop the economics of various processes.

The Committee states that technical progress already achieved on the pyrite-separation project indicates that the development of commercial equipment for economically liberating and separating the pyritic sulfur from coal now appears to be a reasonable possibility.

The Joint Research Advisory Committee consists of J. A. Keeth, Fellow ASME, committee chairman, Kansas City Power and Light Company; T. M. Hotchkiss, Mem. ASME, committee secretary, Southern California Edison Company; A. A. Casey, Mem. ASME, Cleveland Electric Illuminating Company; P. H. Hartung, Public Service Electric and Gas Company; G. L. Barthauer, Consolidation Coal Company; E. C. Payne, Fellow ASME, Mineral Mills, Inc.; and J. E. Tobey, Fellow ASME, consultant.

Henney Kilowatt

RATHER than wait for others to develop an electric automobile for utility fleet use, B. L. England, chairman of the board of the Atlantic City Electric Company, has developed one of his own in co-operation with C. Russell Feldmann, president and chairman of the board of the Eureka Williams Corporation whose Henney Motor Company Division will manufacture the car at Canastota, N. Y.

The small-car body design of the four-door Renault Dauphine is utilized with the rear seat removed to make room for the control. A new stepless controller, jointly designed by General Electric and the designers of the car, operates from a standard gasoline-type pedal accelerator. A dashboard switch serves as the "gear" to shift from forward to reverse. The drive is direct from the motor to reduction gears and the axle.

Power is provided by 36 2-volt batteries—18 under the front hood, and 18 in the rear. A number of small batteries were found more efficient than a few large ones. An auxiliary system provides 12 volts for lighting and for operating turning signals and windshield wipers.

Batteries replace motor in an experimental electric automobile which uses a Renault Dauphine body. Other equipment replaces back seat.

Top speed is 35 mph, with a daily range of 40 miles if run consistently, 50 to 60 miles if operated at maximum speed with frequent stops since the batteries regenerate to some extent during stops of more than 15 minutes. Built-in rechargers will fully recharge the car overnight on 110-volt or 220-volt current. Life expectancy of the batteries is more than 2 years, motor life about 30 years with occasional change of brushes.

Maintenance consists simply of keeping the batteries filled and lubricating nine chassis grease fittings. There are only three instruments on the dashboard—a speedometer, voltmeter, and an ammeter. Weight is 2245 lb of which 650 to 800 lb are batteries.

Present price, with production exclusively for the utility industry, is $3500. Mr. England predicts a strong ultimate consumer demand for second-car use and that marketing will be done by the utilities much as they now sell electric ranges and other appliances. Even with a "fuel cost" of one cent a mile or less in many areas, it is estimated that electric-car owners will double their average load—and all of it will be off-peak current.

Intense heat and a pressure of 1600 psi are combined to butt-weld two different types of metal in a composite welding machine

Composite Welder

A LARGE composite welding machine is being used by Allegheny Ludlum Steel Corporation at its forging and Casting Division plant near Detroit to join expensive tool-steel alloys to less costly mild steel and form composite-die sections. It can weld a 150-sq-in. area in seconds.

The composite dies, in which the expensive tool-steel alloys are used only on the cutting edges, cost 25 per cent less than single-material dies. An intense-heat power supply of 750 kva is combined with 1600 psi to electrically butt-weld the two types of metal. The physical properties of the resistant weld approach the physical properties of tool steel itself.

The range of sizes and shapes of composite die sections is almost limitless. Special shapes with cutting edges of water-hardening, oil-hardening, or shock-resisting tool steel can be manufactured promptly to specification.

Diffusion Welding

ADVANCES in diffusion welding make it possible to obtain excellent bonds at as low as 650 F, metals-joining specialists at Battelle Memorial Institute report. The new method, related to time-honored forge welding, involves the use of one or more intermediate metals to join the base material. The intermediate metals used in studies at Battelle have usually been ones which could be applied by plating.

Intermediate metals make it possible to make joints at temperatures far below those which would be required if two pieces of metal were pressure bonded directly to each other. In some cases, the intermediate metals provide a further advantage. They may also drastically reduce the need for deformation during bonding.

In one application a throat block of Monel metal had cooling grooves cut in its surface and required the attachment of a sheet of beryllium copper to cover the cooling grooves.

While the beryllium-copper sheet could be attached by brazing, problems were encountered in trying to heat-treat the sheet to the strength level required. Diffusion welding solved these problems. By using copper and silver as intermediate materials in the joint, excellent bonds were obtained between the beryllium-copper sheet and the block at 650 F. Since this was the age-hardening temperature for the beryllium copper, the required strength was obtained in the cover sheet at the same time it was bonded to the block. Moreover, bonding at this temperature avoided the distortion which was encountered when brazing was used to attach the cover sheet.

The joints obtained in this application had very high strengths, and in other applications, diffusion-bonded parts have been used at temperatures well above the bonding temperature.

Indian Point Reactor Vessel Shipped

THE 230-ton nuclear reactor vessel for Consolidated Edison's Indian Point power plant has completed its journey from the Babcock & Wilcox Company's Barberton (Ohio) Works to Buchanan, N. Y. It will be the key component in the 275,000-kw generating station.

The vessel and the 26-ton head which will seal it at the top occupied separate flatcars aboard a special Erie Railroad train which traveled only during daylight hours and was sidetracked frequently to permit maintenance of regular Erie schedules. From Jersey City, the vessel and its head traveled by river barge.

Despite the size of the vessel, the alignment of some of the internal parts was held to ±0.007 in. over a length of 30 ft.

Approximately 9500 quality-control inspections and tests were made before shipment. Formed from five shell courses of SA 212 Grade B carbon-steel plate clad with type-304 stainless steel, the vessel walls are more than 7 in. thick.

Other major components B&W is supplying for the system: Four steam generators, a pressurizer vessel, and associated equipment. These have already been delivered and the reactor core is now being made at the company's Nuclear Facilities Plant in Lynchburg, Va., for later delivery. A 160-ft-diam containment sphere made of 1-in-thick steel plate will house the reactor and the primary system.

Of the total output of 275,000 kw, 163,000 kw will be provided by the atomic power plant, and 112,000 kw by two oil-fired superheaters. The reactor will be the first in America to make use of thorium as the fertile material for supplementing the base fuel—highly enriched U-235.

Con Edison was the first utility to announce that it would build a nuclear electrical generating plant entirely with private funds. The company holds Power Reactor Construction Permit No. 1, the first authorized by the AEC under the Atomic Energy Act of 1954.

Flooded-Disk Scrubber

A NEW type of scrubber employing a unique adjustable flooded disk has been developed by Research-Cottrell, Inc., Bound Brook, N. J., for high-efficiency gas-fume cleaning. Present designs are specifically adapted to collecting submicron fumes such as occur in steelmaking furnaces and chemical processes.

Maximum cleaning efficiency is adjustable over a complete range of operating conditions. At gas flows 50 per cent higher or lower than normal, water rates and

pressure drop remain the same while gas-cleaning efficiency is maintained at a high level.

By recirculating dirty water without impairing efficiency, the flooded-disk scrubber also makes it possible to use smaller and more economical effluent-treatment systems. Low-pressure plant water cannot clog large-area water passages used throughout.

Completely automatic operation has been developed to provide continuous automatic adjustment over an entire range of plant operating conditions.

Designed for modern high gas pressures, turbulent flow of a gas-liquid mixture provides an intimate and violent contact between dust and liquid particles. Water or other scrubbing liquid enters through the stem of the disk support and is injected into the gas duct at the center of the disk. The water is deflected to the rim of the disk where it mixes with incoming gas in the annular space between duct and disk. Here the water breaks up into millions of extremely fine particles which collide with and adhere to the dust fume.

Repeated collisions of the fume-water mixture agglomerate and enlarge the particles to a size large enough for separation and collection in a cyclonic mist eliminator which follows the scrubber.

Transfer-Machine Finishing

It is unusual to design a transfer machine for finishing operations, but a Transfer-matic designed and built by the Cross Company, Detroit, Mich., successfully combines high-precision finishing operations with the production economy of automation. Some bore sizes are held to tolerances of ±0.00035 in. and the locations of each of three holes are held to within ±0.001 in. of the other two.

Twin milling operations establish over-all part length within ±0.0039 in. Surface finish specifications are 56 to 110 microin. rms for all machining operations. This five-station precision machine has a production rate of 140 parts per hr at 100 per cent efficiency.

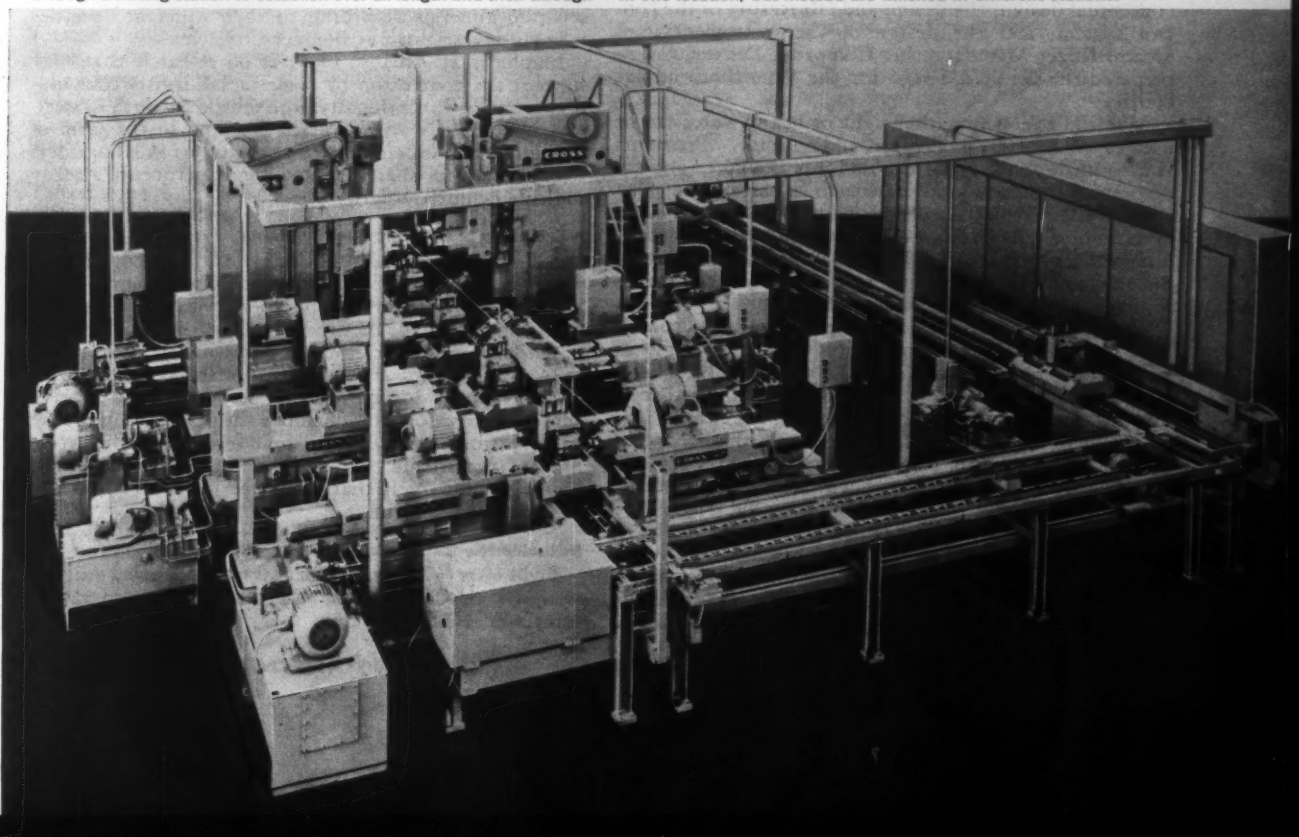
Every detail of the machine has been considered for its effect on accuracy. To insure it, the machine has been designed for high rigidity at each of its four machining stations. Center bases and wings for each station have been made integral to insure proper alignment. Each base has been mounted on a separate foundation so vibrations cannot be transmitted from station-to-station.

Workpieces are clamped, two at a time with the cover faces down, in precision pallet-fixtures. These pallets are accurately located and positively clamped in successive machining stations.

High-accuracy location of the pallets is necessary because not all holes whose locations are tied together by close tolerances could be bored with clustered spindles in one station. Because of their proximity on the workpiece, each of the three holes tied together by the tightest location tolerances is finished in a different station. Each of the eight Cross precision-boring spindles is separately mounted on its slide so that each can be adjusted individually.

Boring bars are made of a solid, heavy metal to damp vibrations and those for the largest holes finish both end holes from the same side of the machine. One of these holes is larger than the other so the boring bar can reach through. Boring bars for these holes each have four microadjustable boring cartridges, one for semifinish and one for finish cuts on each hole. Boring bars for the smaller holes have the same construction and the same individual adjustment for each cutting bit. Two holes are finished with a single straight-fluted reamer.

Over-all view of Transfer-matic machine that holds extremely close boring tolerances while maintaining a production rate of 140 transmission cases per hour. Parts clamped in pallet-fixtures are carried through a milling station to establish over-all length and then through three stations of precision-boring operations. High-accuracy location of the pallets is necessary because not all holes whose positions are tied together by close tolerances could be bored with cluster spindles in one location, but instead are finished in different stations.



Nuclear Briefs

▶ Heavy-Water-Components Test Reactor

THE Heavy-Water-Components Test Reactor, HWCTR, scheduled for start-up early in 1961, is a high-temperature, high-pressure, pressure-vessel reactor cooled and moderated by D_2O.

According to the March, 1960, issue of *Power Reactor Technology*, prepared for the AEC by General Nuclear Engineering Corporation, the $9.3-million reactor which is to have prestressed-concrete containment is being built to test fuel elements and other components for large D_2O systems. It can accommodate 12 test fuel elements of natural or slightly enriched uranium, about 10 ft long, in a region near its center. This region is surrounded by a ring of enriched-fuel "driver" elements to furnish sufficient reactivity for operation. The pressure vessel, 7 ft 2 in. in diam in the reactor region, is designed for 315 C and 1500 psi; the maximum exit operating temperature of D_2O coolant from the pressure vessel is 285 C.

Two in-pile stainless-steel coolant loops will be installed during construction. One loop will be cooled with liquid D_2O and the other with boiling D_2O, with the option that the latter loop be convertible, at some future date, to operation by D_2O steam or CO_2. The loops will have their own make-up, purge-purification, and heat-removal systems independent of the reactor systems.

▶ Spert-II Achieves Criticality

The Special Power Excursion Reactor Test No. 2, Spert-II, the second of a series of versatile facilities developed for studying transients in nuclear reactors, has achieved criticality at the National Reactor Testing Station near Idaho Falls, Ida.

Constructed by Paul Hardeman, Inc., of Los Angeles, Calif., the facility will be operated for the AEC by Phillips Petroleum Company. Phillips also furnished the conceptual design, the design and fabrication of the control system, and the design of the instrumentation. Stearns-Roger Manufacturing Company, Denver, Colo., prepared the detailed design for the $4-million nuclear facility.

In initial operation either light or heavy water can be used as the coolant, moderator, and reflector. Provision is also made for varying the reflector thickness and for accommodating solid reflectors such as beryllium.

Spert-II's primary purpose is to provide the means of determining how various moderator and reflector materials influence reactor behavior. Operations are conducted remotely since some tests approach conditions which could lead to reactor destruction.

The facility consists of a reactor vessel and coolant-flow system designed for operation with either light or heavy water up to 375 psi and 400 F with flow rates up to 20,000 gpm. Coolant flow may be provided in either an upward or downward direction through the reactor core at velocities up to about 25 fps to establish the desired initial conditions prior to transient testing of the reactor. No provisions for continuous heat removal are included, however.

In Spert-I, which has been in operation since July, 1955, sudden power rises are arrested by inherent shutdown or self-limiting tendencies of the reactor itself. Without any external control-rod manipulation, reactor power reaches a peak (one once reached 2.8 billion watts) in a fraction of a second and drops off to much lower but generally steady levels.

In some cases, however, instabilities have been observed following the power peaks. Some of these are divergent oscillations that probably could destroy the reactor, despite its self-limiting characteristics, if allowed to continue. The precise causes of the self-limitation and power instabilities are not known.

▶ Depleted Uranium to Combat Air Pollution

Depleted uranium in the form of uranium hexafluoride has been proposed as a catalyst that could be installed in an automobile-exhaust system to convert gases into harmless substances. Preliminary studies made by the Bureau of Mines indicate the technical feasibility of such an application.

▶ Industrial Uses Needed for Depleted Uranium

Four Bureau of Mines research centers are co-operating with the Atomic Energy Commission to find uses for mounting stockpiles of depleted uranium—the by-product in the form of uranium hexafluoride left after most of the fissionable component, U-235, has been removed. Several thousand tons a year are available if Government or industry can develop applications for it.

The possibility of blending depleted uranium metal with lead, tin, or copper to produce a superior combination for metal bearings is being investigated at Rolla, Mo. Tests are also being conducted there to determine whether sacrificial anodes of depleted uranium will prove more effective than conventional zinc and magnesium in retarding galvanic corrosion of pipelines and other structures that are frequently exposed to this kind of deterioration. (The sacrificial anode, connected to an underground pipeline, underwater ship hull, or similar object, reverses corrosion processes. This reversal causes the anode to disintegrate instead of the object it protects.)

Because uranium is one of the heaviest materials known, the possibility of using it in processes that separate minerals according to their different densities is being investigated at Boulder City, Nev.

Emphasis at Albany, Ore., is on research that may support the contention by some metallurgists that uranium imparts exceptionally high tensile strength to steel.

At Laramie, Wyo., depleted uranium in the form of uranium oxide is being tested as a catalyst in laboratory-scale refining of shale oil, and the experiments already indicate definite promise.

▶ Extrusion of Ceramic Fuel Elements

Allis-Chalmers, and the Electric Autolite Company as subcontractor, have been selected to develop and demonstrate an extrusion process for the fabrication of ceramic fuel elements for the AEC.

The conventional method of preparing ceramic fuels is to press or pelletize uranium oxide or similar nonmetallic fuels into individual pellets that are identical in size and shape. Extrusion would remove the practical limitation to four times the diameter found with pressing techniques, permitting the manufacture of considerably longer ceramic fuels that would be identical to pressed pellets in cross section.

▶ Nuclear-Rocket Reactor Experiments

Field tests of two experimental nuclear-rocket reactors will be conducted this summer in the Rover program, a joint AEC-NASA effort.

Materials Briefs

▶ Elastomer Withstands Gamma Radiation

A FLEXIBLE plastic material which was a scientific oddity only a year ago withstands the damaging effects of gamma radiation better than any known conventional elastomer. Weathering properties are also exceptional.

Known as Estane (5740x1) the material made by B. F. Goodrich Chemical Company could be used to advantage in shielding personnel associated with nuclear-energy and x-ray applications, as well as for gaskets, tubing, pads, and binders for radiation shields.

Secret of Estane's ability to withstand deterioration from heavy doses of radiation lies in the unique chemical structure of the polymer. Gamma radiation either chops long-chain polymers into smaller fragments, making them softer, stickier, and weaker; or chemically bonds the chain together excessively, thus causing the polymer to become brittle. Since Estane (5740x1) molecules are not tied together by actual chemical bonds to begin with they can stand strong radiation doses before becoming nonusable.

▶ Gas-Carrying Aluminum Pipeline

A mile-long, gas-carrying aluminum pipeline has been installed at Cameron, La., for evaluation by Columbia Gas Transmission Company in 1000-psi gas-transmission service. The 6-in-diam seamless-tubular 6061-T6 alloy line required no wrapping or coating and was hydrostatically tested at 1250 psi. Both manual tungsten-arc and automatic consumable-electrode welding were used. Variation in thickness—0.432 in. nominal wall at pipe ends, 0.272 in. elsewhere—was used to cut pipe cost by 20 per cent. Two 8-ft test sections will be alternated in service to permit regular and thorough inspections of the test line.

▶ Desludging Auto-Engine Lubricant

A New Uniflo motor oil announced by the Esso Standard Division of Humble Oil & Refining Company attacks the problem of car-engine lubrication by breaking engine-formed sludge into minute particles less than 0.000001-in. wide. The particles are kept floating in suspension, away from engine parts they would otherwise damage. When the oil is changed, the sludge is drained off with the oil, leaving the engine clean and insuring long engine life.

A combination of properties improves quick starting throughout the year and reduces the amount of engine knock.

▶ Multipurpose Automotive Lubricant

A multipurpose automotive lubricant for commercial and fleet operation of heavy-duty motive equipment has been announced by Shell Oil Company.

Designed to lubricate mobile equipment under adverse and extreme climatic conditions, the Darina Grease AX is based on the company's new waterproof Microgel thickener.

Fleet mileages in tests over a year or more were above a million in many instances. Test mileage on chassis parts was more than 30 million. Wheel-bearing mileage was close to 17 million.

Under dry conditions, the oscillating friction tests were terminated at 2000 hr without failure, which, according to the company, was three times that of the best of the premium multipurpose greases that had been tested.

▶ Boron-Free Brazing Alloy

Problems associated with stainless-steel thin-wall tube heat-exchanger cores used in nuclear reactors have been solved by Stainless Processing Division of Wall Colmonoy Corporation, Detroit, Mich., by furnace processing using Nicrobraz 50 brazing alloy.

Although brazing is best for this application, previous problems were: (*a*) The thin-wall section of the tubes allows very little brazing-alloy diffusion and is readily distorted, and (*b*) the brazed joints are exposed in service to the corrosive effects of circulating water at temperatures up to 600 F.

Absence of boron in the brazing alloy gives it low solubility in the Type-302 stainless-steel thin-wall tubes. Low penetration of the brazing alloy into the base metal minimizes diffusion and possible associated erosion in service. In addition, it produces strong, leakproof joints at low brazing temperatures, 1850 F, which tends to minimize distortion. It is a special brazing alloy which is inherently able to withstand the corrosive effects of exposure to high-temperature water.

▶ Gallium Phosphide Usable to 1500 F

A rare metal called gallium phosphide, which will withstand temperatures up to 1500 F, may help to solve the heat barrier encountered by electronic parts in nose cones of missiles.

The Army Signal Corps Research and Development Laboratory, Fort Monmouth, N. J., has built an electronic diode using this material which has withstood temperatures seven times higher than the silicon and germanium previously used in electronic diodes. The material may also be used in building solar-cell power plants for space stations.

In spite of its temperature-resisting properties, gallium phosphide is composed of two chemical elements which, when apart, melt at low temperatures. Gallium, a rare silvery metal that costs about $1500 a pound in pure form, melts in the hand. Phosphorus, used in matches and fireworks, will melt in the sun on a hot summer day.

▶ Preventing Shrinkage and Cracking in Green Wood

Green wood is claimed not to shrink or crack when the finished product is coated or dipped in polyethylene glycol-1000. Sawed, chipped, or chiseled products can be treated in this way, although the size limitation is not given.

Alfred J. Stamm of the U. S. Forest Products Laboratory in Madison, Wis., discovered that when the melted or dissolved chemical has been applied, the green wood absorbs enough bulk to balance evaporation in all structures. The treatment seems to act as a decay preventive, too.

For a finishing coat, Dr. Stamm favors a polyurethane varnish.

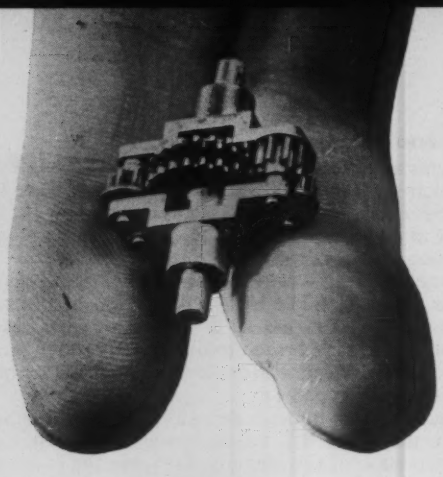
▶ Plywood Pipelines for High-Sulfur Oil

Plywood pipelines have been successfully used in Russian oil fields where the high sulfur content of the oil had been causing excessive corrosion of metal pipes.

According to the March 25, 1960, issue of the British journal *Engineering*, the change to plywood was first made at the Baku oil field but has been extended to other areas.

Similar pipes are being used at Lvov for water mains, "presumably without harm to the water."

The pipes have diameters between 50 and 300 mm (2 to 12 in.) and are made in Leningrad and the Urals.



Differential for a Dime. Gries Reproducer Corporation, New Rochelle, N. Y., sells this tiny gear set for less than 10¢ for tuning devices, toys, vending machines, animated displays, record players. They die cast zinc-alloy gears and housings—an exclusive, high-speed, fully automatic technique.

PHOTO BRIEFS

M. BARRANGON

1 Dice-Sized Modules. That card in the man's left hand can do the work of the 23 printed-circuit boards on the table. The modules, each weighing two grams, were designed by Republic Aviation for an all-purpose digital computer. Their "packing density" makes them suitable for missile-guidance systems, which call for extensive computer "logic" within severe space-weight limitations.

2 MACE Recovery. This Martin-built missile is designated MACE No. 175-4, and the "4" means it has been successfully flown and recovered four times. The "bird," an Air Force surface-to-surface tactical missile flown by a ground pilot, packs a parachute recovery kit in place of a warhead. Every time it is recovered, the taxpayers have been saved several hundred thousand dollars.

3 Reactor Core. Technicians of Westinghouse are shown removing one of the 32 fuel elements from the core of the first U. S.-built power reactor designed for use abroad (Belgium). The core, for use in an 11,500-kw atomic power plant, underwent a comprehensive testing program. It consists of 3536 fuel rods in 32 "bundles," each tube containing 90 uranium-oxide pellets.

4 Precision-Drilled Circuit Boards. When Librascope Division of General Precision, Inc., Glendale, Calif., switched over to automated component assembly, they had to develop precise drilling for circuit boards. Five boards are positioned on a plate, on which the drilling pattern is etched. As the positioning finger drops into each indentation, the drill operates from underneath the table.

5 Mobile Scaffolds. At Newport News Shipbuilding and Drydock, two fork trucks equipped with scaffolds have reduced labor and maintenance costs on ship repairs. Two Clark trucks of 20,000-lb capacity can put the top of the scaffolds 41 ft up, providing a work area for riggers as they clean, paint, inspect, and repair the hulls of vessels. Railroad cranes used to be tied up for this service.

6 Dummy Missile. The Polaris missile, for launching from a submerged submarine, gets its first underwater testing by means of a full-scale dummy, the "Dolphin." Lockheed designed the dummy, known as Launch and Training Vehicle (LTV). The Dolphin is shown clearing the surface by a few feet—after which it drops back, its launch energy dissipated, and is recovered. It carries neither warhead nor fuel.

Bomber Destroyer. This is the first air-to-air guided missile with nuclear capability. The GAR-11 Nuclear Falcon, newest weapon of the U.S. Air Force, was developed by Hughes Aircraft, Culver City, Calif.

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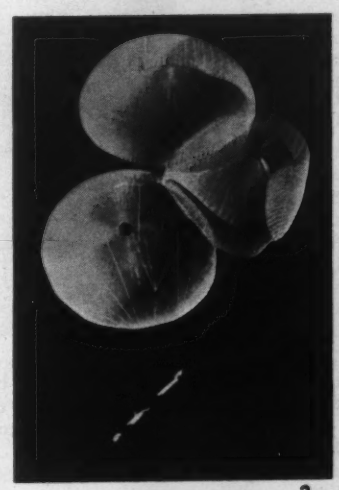

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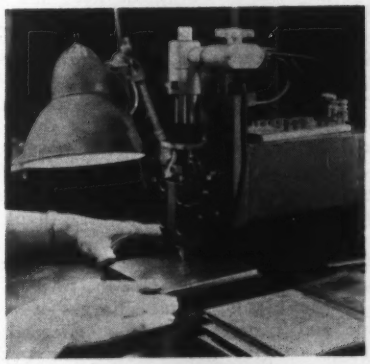

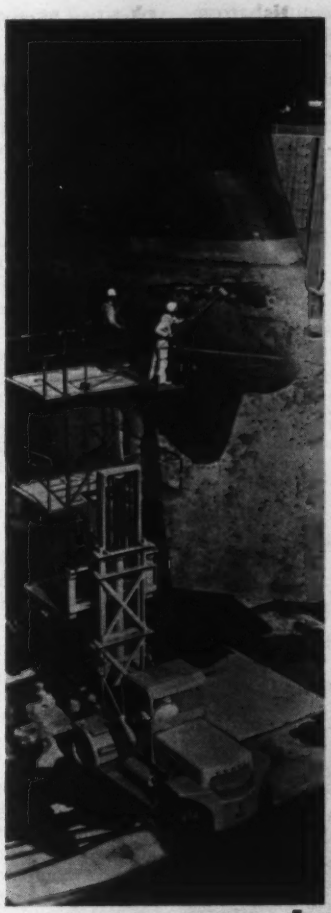

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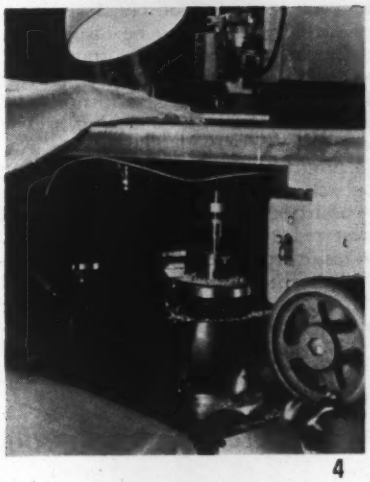

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Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

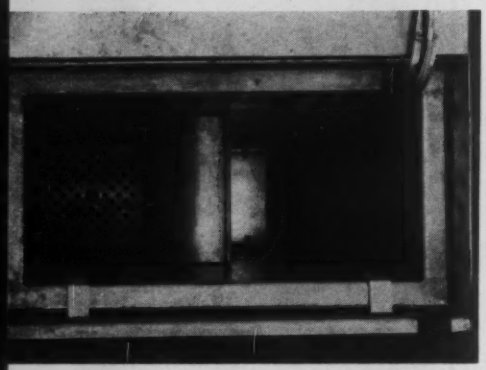
EUROPEAN SURVEY

Degreasing Plants

IMPERIAL CHEMICAL INDUSTRIES LTD., England, in their General Chemicals Division, have developed a new type of metal-degreasing plant designed for use with trichloroethylene. The smallest size, the ULV 1, which is illustrated, has a compartment no more than 9 in. by 7 in. and 7 in. deep.

Ultrasonic generating equipment is connected to a sealed stainless-steel transducer unit containing barium-titanate elements, submerged in cool trichloroethylene. Electrical impulses at 40 kc per sec are changed to mechanical vibrations which produce cavitation in the solvent. This intensifies the natural effect of the solvent and also detaches insoluble particles, if present.

The solvent is circulated by a pump through a filter, where any solids are collected. In the other compartment of the unit is electrically heated boiling trichloroethylene beneath a vapor layer. Vapor rises to the condensing coils, falls as liquid into the ultrasonic compartment, and thence flows over a weir back to the boiling liquor compartment. A water coil restricts the temperature to 60 C, to avoid damaging the transducers.



ULV 1 plant from above, showing ultrasonic and boiling liquor compartments

The ULV 1 ultrasonic cleaning plant from the front. The pump and filter for collecting solids from the ultrasonic compartment can be seen, respectively, above and below the projection on the right of the plant.

Dishing Metal With Explosives

THE Research Department of Vickers-Armstrongs (Engineers) Ltd., at Crayford Works, near London, England, has been experimenting with the high-speed forming of metal plates by the use of high explosives. To make the investigation as realistic as possible, it was decided to try to produce a scale model, one-twelfth full size, of the domed end of a pressure vessel. The blanks used were of bright mild steel 0.036 in. thick, and the explosive was Tetryl (C.E.). The diameter of the finished dome was to be 10.2 in., the depth 2.65 in., and the radius of the dished portion, 7.8 in.

The apparatus devised comprised a mild steel die, an annular pressure plate, a vacuum pump, and a sheet-metal cylinder about 16 in. high. The parts were assembled as shown in the accompanying diagram, the cylinder being filled with water and the explosive charge suspended in it. Air was evacuated from under the blank before the charge was detonated.

The charges used ranged in weight from 30 grains to 80 drams, and they were located from $2^1/_2$ in. to 8 in. above the center of the blank. Some charges were cylindrical in shape and others were hemispherical; the latter form seemed to give the more satisfactory results, though the evidence was not conclusive. A vacuum of 24 in. of mercury proved to be insufficient. Residual air in the die caused dents in the dome ends. The best results were obtained by using hemispherical charges of 400 grains, located $2^1/_2$ in. above the center of the blank, and a vacuum of 29 in. of mercury. The die was given an entry radius of $^1/_2$ in.

The dome ends so produced varied little, there being practically no springback of the material, and the finish was good. There was little change in the thickness of the steel, the greatest reduction being about 0.003 in. This was assumed to result from the uniform distribution of the explosive. While this method of forming metal cannot compete with normal press work when large quantities are required, it is considered to have possi-

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

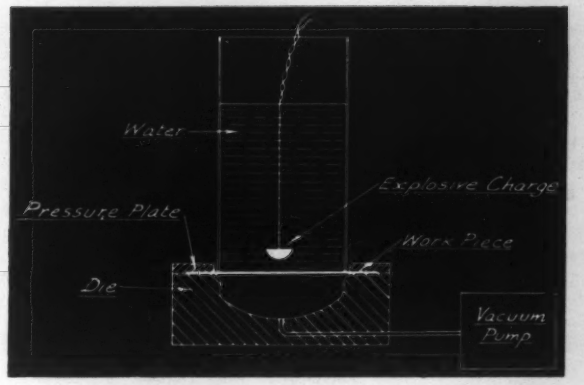


Diagram of the apparatus used for the forming of metal plates using high explosives

bilities for small quantities of components, required to be of good finish and within close dimensional tolerances.

3000 Hp Per Cylinder

FIAT Stabilimento Grandi Motori, of Turin, Italy, whose experimental two-cylinder marine diesel engine was described and illustrated in the "European Survey" for February, 1960, have been testing it further to ascertain its ability to withstand very high loads. In the previous reference to this engine, which is designated the Type 900 S, it was stated that an output of 2650 hp per cylinder had been attained, claimed by the FIAT firm to be the highest ever reached in an internal-combustion engine. That figure has now been exceeded to a sustained output of slightly more than 3000 hp per cylinder over a period of 30 min, at a speed of 122.9 rpm.

The mean effective pressure was 11 kg per sq cm (156.5 psi). The test was subsequently repeated for the benefit of representatives of the marine classification registries. An output per cylinder of over 3000 hp was held for 30 min and a steady 2750 hp per cylinder, corresponding to an mep of 10 kg per sq cm (142.2 psi), was maintained for two hours.

At the maximum loading the temperature at the inlet to the exhaust-gas turbine driving the scavenging blowers was 422 C (792 F). The exhaust was clear at all times; there was no thermal or mechanical trouble.

The engine is a single-acting two-stroke, 900-mm bore and 1600-mm stroke, cross-scavenged and having a constant-pressure supercharging system with centrifugal blowers, driven by gas turbines, in series with reciprocating air pumps operated by the main pistons. This system has the advantage that the air quality and pressure are not limited by the capacity of the exhaust-gas turbine. The engine will deliver more than 70 per cent of its normal output with the turboblowers out of action.

Underwater Oil Drilling

Shell International Petroleum Company, London, England, has announced that the mobile underwater oil-drilling platform "Triton," at Cardiff, South Wales, will soon be transferred to the Dutch coast for a program of offshore drilling. The Triton, which is 115 ft long and 80 ft wide, can be raised clear out of the water by hydraulic power on four tubular steel spuds resting on the sea bed. The specification was drawn up by the Bataafse Internationale Petroleum Maatschappij (BIPM). The main contract was placed with the American construction firm of De Long, who subcontracted the hull and the four spuds to the shipyard of Clelands (Successors) Ltd., at Wallsend-on-Tyne, England.

Near the coast of South Holland, the Triton will be operated by the N.V. Nederlandse Aardolie Maatschappij (NAM), a company in which BIPM and Standard Oil of New Jersey have equal interests. While seismic exploration is being carried out to determine the most likely sites for exploratory drilling, the Triton will be equipped with NAM's latest type of diesel-electric drilling rig and provided with a landing deck for helicopters. The craft can operate in water up to 120 ft deep. The four retractable legs are 8 ft in diam and 200 ft long. The lowest sections have the diameter increased to 16 ft to reduce the penetration into the sea bottom.

The Triton, a mobile oil-drilling platform, the second to be constructed in the United Kingdom, is ready for drilling. It was built for Shell International Petroleum Company, London, England, by Clelands Shipbuilding Company

Substance in Brief of Papers Presented at ASME Meetings

ELEANOR RAMP
Edit. Asst.

ASME TECHNICAL DIGEST

Applied Mechanics

Subharmonic Oscillations of a Pendulum ..59—A-94... By Richard Skalak, Columbia University, New York, N. Y.; and M. I. Yarymovych, AVCO Corporation, Wilmington, Mass. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Large amplitude oscillations of a simple pendulum whose support moves with a prescribed vertical oscillation are studied by an approximate method.

Subharmonics of order 1/2, 1/4, 1/6, and 1/8 are discussed and the theoretical results are compared with experiments.

The stability of the theoretical steady states is investigated by the method of Andronow and Witt.

The Contact Problem for Viscoelastic Bodies..59—A-83... By E. H. Lee, Mem. ASME, Brown University, Providence, R. I.; and J. R. M. Radok, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The contact problem in viscoelasticity is one in which different types of boundary conditions are prescribed depending on whether boundary points inside or outside the region of contact are considered.

Since, in general, the contact region varies with time, this leads to a problem which cannot be treated directly by application of the Laplace transform, which has formed the basis for most published viscoelastic stress-distribution solutions.

It is shown that the solution of the viscoelastic counterpart of the Hertz problem in elasticity can, however, be deduced from the elastic solution.

A particular example is presented, and the marked effect of viscoelastic behavior on the pressure distribution in the contact region is illustrated.

The problem also illustrates the tentative nature of the method of approach and the need for a separate confirmation of the solution.

The solution is presented for general linear viscoelastic operators, and offers the possibility of determining these from a contact test.

Stresses in the Plastic Range Around a Normally Loaded Circular Hole in an Infinite Sheet..59—A-130... By O. L. Mangasarian, Shell Development Company, Emeryville, Calif. 1959 ASME Annual Meeting (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The stresses in the plastic range around a normally loaded circular hole in an infinite sheet are found numerically on the basis of both J_2 deformation and incremental theories.

The results of deformation theory are quantitatively assessed in the light of a criterion, recently developed by Budiansky, for the acceptability of deformation theories.

The criterion is completely satisfied. Moreover, the results obtained by using these two different theories of plasticity do not differ greatly despite the fact that the stress paths are far from being radial.

On the Optimum Design of Shells..59—A-47... By R. T. Shield, Brown University, Providence, R. I. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

A procedure is developed for obtaining the design of an elastic, perfectly plastic shell or structure which will support prescribed loads and which is the optimum design for a given criterion.

The action of body forces is included in the analysis.

Some problems in the minimum volume design of a circular cylindrical sandwich shell are solved to illustrate the method, and it is found that only for relatively short shells does the minimum volume design effect an appreciable saving over the membrane design.

Yield Conditions for Rotationally Symmetric Shells Under Axisymmetric Loading..59—A-129... By P. G. Hodge, Jr., Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The yield condition for a rotationally symmetric shell may be represented as a surface in a four-dimensional stress space.

The exact yield surface according to the Tresca yield condition is compared with various approximations.

A new approximation is suggested which combines the advantages of mathematical simplicity and reasonable accuracy.

The theory is illustrated with reference to a spherical cap under uniform pressure.

Correlation of Theoretical and Photothermoelastic Results on Thermal Stresses in Idealized Wing Structures..59—A-36... By Herbert Tramposch, Mem. ASME, and George Gerard, Mem. ASME, New York University, New York, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

After a rather complete exploratory program described in previous papers, the photothermoelastic method was applied to the experimental evaluation of thermal-stress theories.

The new technique was correlated with several theories which analyzed the transient thermal stresses in idealized wing structures of high-speed aircraft.

Various theories were investigated which represented the same idealized wing models and differed from each other only in the simplifying assumptions regarding the temperature distributions in skin and webs.

The theories were evaluated by duplicating the boundary and initial conditions on plastic models and then by cor-

relating the theories with the observed fringe orders in nondimensional form.

A significant general conclusion was reached after correlating the available theories and experimental results.

Owing to simplifying assumptions concerning the thermal behavior in the flanges, thermal stresses predicted by the available theories are all higher than the experimental observation.

In some cases the discrepancy is as great as 30 per cent.

Solar-Energy—Heat Transfer

Analysis of Solar-Furnace Performance in Mechanical Testing at Extremely High Temperatures..59—A-79...By G. L. Leon and M. E. Shank, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Annual Meeting paper (in type; to be published in Trans. ASME—J. Engng. for Power; available to Oct. 1, 1960).

The use of the solar furnace for investigating properties of materials has received increased attention. However, such work has been limited to determining physical properties of refractory materials. Analyses of performance, related to such work, have been confined to investigations of flux distribution and temperature on flat-plate, hemispherical, and cavity receivers at the focal spot. Heat conduction away from the focal spot usually has not been considered.

The present investigation is concerned with the analysis of fluxes and temperatures that can be attained in tensile specimens undergoing mechanical tests.

Account is taken of heat loss by conduction and reradiation. It is shown that (*a*) attainable temperatures are considerably lower than those reached in flat-plate receivers; (*b*) with normal low-aperture furnaces (i.e., 60 deg) a large furnace is necessary to reach high temperatures with adequately large specimens; and (*c*) furnaces best adapted to mechanical testing would have larger apertures (120 deg) than are now commonly conceived.

Gas Turbine Power

Experiences With Gas Turbines in French Power Stations..60—GTP-1...By P. Chambadal, Electricité de France, Paris, France. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

In 1953 and 1954, Electricité de France, which is France's national electricity supply company, ordered five gas turbines of about 6000-kw power output for peak-load generation. All of them are intentionally of different designs, the main purpose of the program being a technical and economical comparison of many possible solutions. Four of the five sets are now in operation, and the purpose of this paper is to give some information about the progress achieved with them.

Solutions adopted for two very important problems are shown; one of them the problem of burning heavy fuel, the other the problem of remote control of the unit. Each of these problems has been solved for a gas turbine operating with a rotating compressor as well as for a turbine combined with free-piston gasifiers.

Salient features of a high-temperature gas turbine operating with heavy fuel at the Saint-Dizier power station are pointed out. Compared with this is the Cherbourg plant using heavy fuel in free-piston gasifiers.

Improvements of the peak-load free-piston engine plant with afterburning and remote control at the power station of Tours are given. A two-shaft gas turbine with remote control, built by the Société Rateau, is described.

Gas turbines as well as free-piston gasifiers are now proved heat engines from which can be expected reliable and easy service, but to be economical as possible, that means operation with a cheap fuel and reduced labor. Results attained so far have been satisfactory with each of the two kinds of heat engine.

Three Years' Operating Experience With 7500-Kw Gas-Turbine Plants in Belgian Steelworks..60—GTP-3...By E. Aguet and J. von Salis, Sulzer Brothers Limited, Winterthur, Switzerland. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Gas turbines are being used in increasing numbers in the European steel industry, utilizing as fuel blast-furnace gas, and producing either electric power or blast-furnace wind; in some cases both combined.

A stage has now been reached where these units can offer reliable and economic operation, and it is the purpose of this paper to describe in some detail three 7500-kw gas turbines installed in Belgium with which operating experience of up to four years has now been gained.

Except for a few minor setbacks such as build-up of deposits in one turbine owing to the fairly high dust content of the blast-furnace gas, the gas turbines proved that they can fully satisfy industrial requirements.

Power output and efficiency in all cases surpassed the calculated and guaranteed values. Favorable operating experience as well as the rapid and trouble-free starting up after erection on site shows the gas turbine to have fulfilled all expectations from the maintenance point of view.

Considerations for Gas Turbines and Their Initial Operating Experiences at El Convento..60—GTP-4...By O. H. Pfersdorff, Mem. ASME, La Electricidad de Caracas, Caracas, Venezuela. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

This paper is presented to set forth the initial operating experiences and results of two highly controlled gas-turbine units for power generation.

A description is given of the growth of the Compania Anonima La Electricidad de Caracas, a private public utility wholly controlled by Venezuelan capital.

The individual turbine arrangement, fuel systems, control systems, start-up and operating problems, and a comparison of test and design data are stated. The future outlook for gas turbines in the Electricidad de Caracas system is discussed.

The author states that the world's first completely remote controlled gas turbines for power generation will supply peak and emergency power to the system of C. A. La Electricidad de Caracas.

A Rapid Starting Automatic Gas-Turbine Generating Plant for Peak-Load Duty..60—GTP-2...By B. G. Markham, Bristol Siddeley Engines, Ltd., Filton, Bristol, England. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Gas turbines have been used to a negligible degree in the United Kingdom for stationary purposes since nearly 75 per cent of all stationary gas turbines in the United States use natural gas which is unavailable in the United Kingdom.

It is anticipated that there will be two rather distinct lines of development in the U. K.—the further exploitation of the low-temperature gas turbine using low-grade fuel and with waste-heat recovery for base-load duty, and the introduction of the low-capital-cost high-temperature engine using distillate fuel for intermittent or emergency duties.

This paper is concerned with the high-temperature type engine which is characterized by a capital cost of about $^1/_3$ of that of an equivalent low-temperature engine.

Economics of peak-load plants, importance of low capital and stand-by charges, rapid starting and full-load without warming up, and description of a 3-megawatt plant based on aircraft type of gas turbine are considered.

Automatic controls and safety devices, installation, silencing, and prob-

lems of compressor fouling are also treated.

Operating Experience of Nimonic 80A First-Stage Buckets in Natural-Gas-Burning Turbines..60—GTP-8... By G. R. Heckman and A. W. Herbenar, General Electric Company, Schenectady, N. Y. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

As a result of critical material shortages during the Korean conflict, Nimonic 80A, a nickel-base alloy, was substituted for S-816 in first-stage buckets for 5000-hp gas turbines. Original evaluations of long-time performance indicated adequate strength; however, premature failures occurred in 1956 after 15,000–20,000 hours of operation.

It is the intent of this paper to summarize the results of a series of metallurgical investigations which were conducted to determine whether these failures resulted from abnormal operating temperatures, material deficiencies, unreliable parametric extrapolations or a combination of these factors.

From present evaluations and results obtained, the first-stage Nimonic 80A bucket failures can be explained in two different ways. The first explanation implies that the material was normal in every respect and that failure was due solely to overtemperature during operation. While this appears to be an oversimplification of the problem, it is consistent with temperature conditions which might have existed especially during starting.

The second, more plausible explanation, supported by considerable evidence from these investigations, is that Nimonic 80A buckets failed prematurely in rupture as a result of structural instability which caused embrittlement of the grain boundaries.

The embrittling phase nucleated and grew during service as a result of a single-aging treatment in which the final aging temperature was not too remote from the operating temperature. Other factors which greatly contributed to the structural instability and growth of cellular colonies are (*a*) the chemical inhomogeneity that existed in the segregated bar stock from which the buckets were made, (*b*) the strain energies induced by thermal-cycling normal operating stresses and particularly cold-straightening or gagging, and (*c*) operational temperatures near or in excess of the aging temperature.

It is further concluded that the modified heat-treatment involving a double-aging cycle provides a more ductile and stable structure required for long-time operation.

This treatment has been applied to all Nimonic 80A forged buckets which are now in service. This modification, together with blunting the leading edge and changes in the starting cycle to minimize thermal stresses, should result in excellent long-time performance of the material.

Gas-Turbine-Exhaust Heat-Recovery Cycle..60—GTP-9... By G. L. Morris, Mem. ASME, Brown and Root, Inc., Houston, Tex. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

This paper is based on an operating industrial installation that the author's company has engineered and constructed.

It presents the various studies made by the engineers to arrive at the best all-around solution, based on installed cost, ease of operation, simplicity, and over-all cycle thermal efficiency.

Major elements of the installation are as follows:

1 Two 7500-hp simple-cycle gas turbines for driving process equipment.

2 Two 30,000-lb/hr watertube, two-drum, pressurized recovery boilers complete with a stack-type economizer, for heating feedwater for the recovery boiler and power boiler plus a separate economizer for process feedwater heating.

3 Two 40,000-lb/hr watertube, two-drum, balanced-draft power boiler capable of using either air or turbine exhaust gas for combustion air.

The Behavior of Gas Turbine Combustion Chambers While Burning Different Fuels ..60—GTP-10... By C. Kind, Brown Boveri Corporation, Baden, Switzerland. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

The gas turbine is a versatile prime mover which has capacity for burning different fuels, from very heavy to very light. In order to gain full benefit from the versatility of the gas turbine, it is desirable for combustion chambers to be designed which can burn widely different fuels without modification.

Whereas the distribution of gaseous fuels in the firing zone affords quite wide scope as regards the design of the burners, the atomization and mixing of liquid fuels demand more complicated equipment. Atomizing nozzles, unlike simple gas jets, cannot be provided in unlimited numbers or fitted almost anywhere.

The outcome of these facts is that the designs of nearly all the combustion chambers dealt with herein are based on models which are suitable for burning liquid fuels.

Large single combustion chambers with vortex mixing appear to be very suitable. A primary condition for this is that the input of fuel should be appropriately adapted to the air-flow conditions on which the design is based.

The different examples given show that it is technically feasible to construct gas-turbine combustion chambers which are suitable for use with all industrial fuels. In extreme cases, small modifications and additions may be necessary; however, these do not involve any fundamental change in the conception of the design, provided that mixing is deliberately brought about and not simply left to chance.

Development Experience With Prototype Gas Turbines..60—GTP-13... By J. E. Cook, Standard-Vacuum Oil Company, White Plains, N. Y. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

In 1956 Standard-Vacuum Oil Company built fluid catalytic-cracking plants in two Asian refineries, using four identical 3000-hp gas-fired turbines to drive main air blowers and gas compressors. A newly designed, unproved gas turbine was purchased for this application.

This paper describes the major field problems encountered and modifications necessary to put the unit into commercial operation.

Severe blade damage due to sulfur in fuel gas, the fouling of combustor air baffles, thrust bearing failure, axial-compressor fouling, and the effects of high ambient temperatures were experienced and corrected by the co-operative effort of manufacturer's and owner's overseas field personnel.

After describing the difficulties experienced in gas-turbine performance the author concludes that gas turbines should be designed for about 15 to 20 per cent excess capacity over maximum load requirement. This would permit a reasonable amount of compressor fouling and seasonal rise in ambient without the necessity for reducing load on the driven unit. This added design capacity should be accepted as a fouling factor just as is done in the case of heat-exchanger design.

Operation and Maintenance of Remotely Controlled Gas-Turbine Units..60—GTP-14... By R. C. Hill, R. H. Hubbell, and M. L. Krapp, Trans-Arabian Pipe Line Company, Beirut, Lebanon. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Trans-Arabian Pipe Line Company and the Arabian American Oil Company have installed a group of portable auxiliary pumping units at intermediate locations on the crude-oil pipeline across Arabia to the Mediterranean. The units

are powered by 5000-hp General Electric gas turbines burning crude oil for fuel and are controlled by radio from upstream pump stations.

Operating experience between 1957 and September, 1959, indicates that the design promise of 80 per cent operating factor was conservative. Intensive effort has been applied to overcome mechanical faults, crude-oil combustion problems, and control instability.

Major problems are discussed in detail with a description of the methods and facilities used to reduce the effect on operating reliability and maintenance expense. The paper briefly discusses development work now in progress which is expected to smooth out seasonal capacity fluctuations and possibly result in a substantial increase over design rating.

Since much of the development work is still in progress, it is the intent of this paper to review the operation of the subject pumping units to date. It is intended that a paper to follow this one at a future date will report in more detail the operating experience as a result of the work now being done.

Economics of the Steam-Gas Turbine Exhaust-Fired Cycle for Medium-Size Utilities..60—GTP-15... By M. Eisler and W. M. Sybert, Mem. ASME, Kaiser Engineers, Oakland, Calif. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

All electric utilities are faced with the problem of optimizing the addition of new generating units to provide adequate capacity as predicted by the load-growth forecasts. Smaller capacity additions permit closer matching of the load-growth curve, but larger units have a lower capital cost per kilowatt.

The conflict between installing small generating units at a high capital cost per kilowatt, or larger units at a lower kilowatt cost, but resulting in excess system capacity, is particularly acute for the small and medium-size electric utilities.

For these systems, the combined steam-turbine gas-turbine exhaust-fired cycle (GASTEF) considered in this paper may be of special interest.

This cycle permits a "building-block" approach; i.e., the gas turbine can be added to a new or an existing steam station at an optimum time, allowing deferment of the next steam-turbine installation. This building-block concept permits closer matching of the load-growth curve with all the advantages of the combined plant as an additional benefit.

Why the maximum GASTEF plant capability is significantly higher than the capability of a conventional steam-electric station having an identical steam turbine is explained. Plant investment, modes of operation, and examples of such systems are given to demonstrate that considerable capital-cost savings are possible through the building-block method of installing steam turbines and gas turbines for operation in GASTEF cycle.

The fact that gas turbines can be integrated with steam turbines in combined cycles of higher efficiency than the steam cycles themselves, and that additional steam-turbine capacity results from proper heat-recovery procedures, makes this application interesting and worthy of consideration.

Report on 9000-Hr Operation of Marine Propulsion Gas Turbine in the John Sergeant..60—GTP-5... By H. D. McLean, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y.; C. C. Tangerini, Maritime Administration, Washington, D. C.; and W. H. Van Cott, United States Lines Company, New York, N. Y. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

The purpose of this paper is to continue the dissemination of operating and performance information, and evaluation of the gas turbine in the converted Liberty ship, *John Sergeant*. A detailed report is made on the inspection of gas-turbine parts and the favorable condition shown.

Service experience of the gas turbine in the *John Sergeant* demonstrated high adaptability and favorable potential for a marine drive. Low-vanadium residual fuels are readily handled with an on-board fuel-treatment system and availability of satisfactory residual fuels in several European bunkering ports has greatly broadened the operating range of a gas-turbine ship.

The *Sergeant* has demonstrated the practicability of operating a residual-oil-burning gas-turbine plant with two men per watch, even considering unfavorable washing arrangements imposed by conversion compromises.

It could be operated with no engine-room watch standers by supplying prewashed and pretreated residual oil to the ship or by the use of the lowest grade distillate fuel that meets fuel-oil specifications.

Design improvement suggestions for a new ship are evaluated and recommendations are made for future marine applications.

Gas-Steam Power Generation..60—GTP-6... By P. F. Martinuzzi, Mem. ASME, Stevens Institute of Technology, Hoboken, N. J. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

The combination of a gas turbine with a steam turbine driven by steam produced in a generator heated by the gas-turbine exhaust has many advantages.

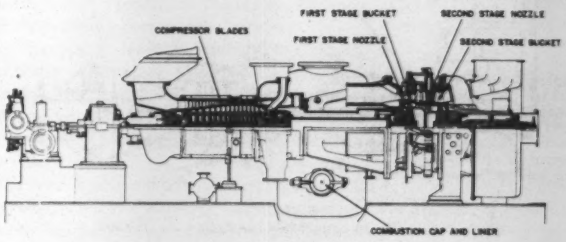
This paper deals with gas-steam power plants in which a gas turbine produces power and the exhaust heat generates steam, which is used in a steam turbine to add to the power.

The field of application of such a gas-steam power plant is examined, as well as the best operational characteristics of the combination. Limitations and advantages in operating conditions for open and closed-cycle gas-steam gas turbines are examined for cycles working at present-day temperatures.

The special features of closed-cycle gas turbines, particularly of the type used in conjunction with gas-cooled, high-temperature nuclear reactors, are shown to give considerable advantages when combined with a steam turbine. These advantages are so great that further study and experimentation are well justified, but organically designed gas-steam power plants will not be in service for several years.

Smoke Reduction in Residual-Fuel-Burning Gas-Turbine Combustion System..60—GTP-7... By R. B. Schiefer, Assoc. Mem. ASME, J. B. Gatzemeyer, and N. R. Dibelius, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Modern air-pollution and smoke-abatement legislation has placed a new requirement on the gas-turbine combustion design engineer; namely, that of provid-



Cross section of the marine-propulsion, two-shaft, open-cycle gas turbine in the **John Sergeant** (60—GTP-5)

ing for the prohibition of smoke in the turbine-exhaust gases.

As a result of the requirement that a gas-turbine-electric locomotive operate in areas where legislation prohibits operation if the smoke in the exhaust gases exceeds a specified amount, a program was undertaken to develop a combustion system which would meet the requirements without compromising the other performance criteria.

A description is given of the method of attack taken in one particular case of smoke reduction. First, the combustion system and test facilities are discussed. Results of laboratory tests, full-scale single combustion tests, and the engine tests are presented.

Physical and chemical nature of smoke, the objective measurement of smoke, the effect of operating variables on smoking tendency, and considerations which led to a combustion-chamber design which met the requirements as evidenced by the engine test results are presented.

Conclusions reached are as follows:

1 Smoke from gas-turbine combustion systems burning residual fuel oils is primarily composed of carbon particles formed by cracking vaporized fuel.

2 These carbon particles escape being burned because of too rapid chilling by the dilution air or by being aspirated into the liner sheathing air stream.

3 Attention to rate of air admission and the directions of air flows can make very significant improvements in smoke without sacrificing lean blowout performance.

4 In this program, the correlation of smoke measurements on the gas turbine on the single-chamber combustion test stand were within the normal expected repeatability of the smoke measuring equipment.

5 It is possible to burn residual fuel oils in a gas turbine without exceeding the smoke limits imposed by most smoke ordinances.

1100-Hp Gas Turbine for Marine Applications..60—GTP-11... By R. G. Mills, Mem. ASME, Department of the Navy, Washington, D. C.; and P. A. Pitt, Solar Aircraft Company, San Diego, Calif. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Major considerations in the initial draft, three years ago, that led to the Saturn engine, were less weight and space for a higher horsepower prime mover and for the fuel required to perform its mission.

The development and design approach to the achievement of the engine are described in detail. The 1100 gas-turbine engine is a high-performance unit that uses a simple thermodynamic cycle. Its characteristics include its smallness, being 77 in. long, 44.9 in. wide, and 44 in. high; its typical weight of 1250 lb; and its weight-to-power ratio of approximately 1.14 lb per hp. It operates on MIL-F-16884 diesel oil for marine applications and its design allows it to operate on almost any type of fuel.

Designed for long life and low weight, the engine is intended specifically for intermittent and continuous duty in marine and ground installations, filling a growing requirement for a light compact prime mover for the propulsion of high-speed boats and landing craft, and for driving 500-750-kw shipboard electric generators.

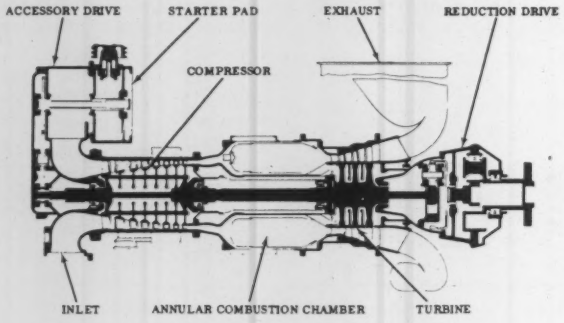
Attention is given to the aerodynamics, the turbine, bearings and seals, combustion, reduction and accessory gears, lubrication system, and the fuel-control system.

The success of the Saturn engine-development program is attributed to strict adherence to the following principles:

1 Careful aerodynamic design to attain high performance.

2 Use of moderate temperatures and low stress levels to insure long life.

3 Conservative mechanical design and exhaustive component testing to obtain ruggedness and reliability.



Cross section of the Saturn single-shaft gas-turbine engine showing internal relation of component parts (60—GTP-11)

Operational Experience With a 15-Mw Gas Turbine Generator in an Iron and Steel Works..60—GTP-16... By F. K. Konig, Huttenwerk Rheinhausen, A. G., Rheinhausen, Germany. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Interest in the development of the gas turbine has been followed by the iron and steel industry since blast-furnace gas, produced as a by-product in the blast furnace process, is the principal source of energy used in an iron and steel works and appears to be specially suitable for use in gas turbines. Blast-furnace gas is the basis of power production, hence the interest in its conversion into electric current.

The gas turbine offered possibilities of obtaining comparatively high efficiencies even with relatively small power production. One disadvantage of the use of blast-furnace gas in gas turbines is the necessity of compressing the gas before combustion is commenced, entailing the expenditure of much more power than does the injection of oil, resulting in a reduction of over-all efficiency. There is an advantage, however, that the blast-furnace gas is in general a very amenable fuel.

The author describes the basic philosophy for the installation of gas turbines burning blast-furnace gas in the power-generating systems of an iron and steel works and the operating experience of the two gas-turbine generators at the Huttenwerk Rheinhausen, A. G.

A Fluid Mechanics Approach to the Labyrinth Seal Leakage Problem..60—GTP-12 ... By Géza Vermes, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Jan. 1, 1961).

More than 50 years ago a formula was first presented in a British periodical by Prof. A. M. Martin for the computation of the rate of flow through a labyrinth packing, but the problem still keeps haunting mechanical engineers.

Maintained investigations on the subject are due to the rapidly growing size of turbomachinery making investigation of relatively small losses worth while and the possibility of leakage of contaminating nature requiring a more accurate calculation procedure. Another impetus may be due to the fact that, as flow processes become more amenable to calculation, the possibility of understanding more complicated gland processes became apparent.

This paper describes investigations of labyrinth seals carried out recently and derives new theoretical and semitheo-

retical formulas for computation of the leakage which agree within five per cent with the tests for three different types of seals (straight, stepped, and combination seals). Relatively simple considerations of a fluid-mechanics nature allow the extension of the validity of Martin's formula for ideal seals to seal configurations in industrial use.

Off-design performance of the seals is treated theoretically and experimentally; the formulas describe the off-design performance of the seals mostly within eight per cent but at least within 15 per cent of the test results.

Description of a 9000-Hp Single-Shaft Gas Turbine..60—GTP-18... By O. C. Schoeppner, Clark Brothers Company, Olean, N. Y. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Low first cost and little need for maintenance insure the industrial gas turbine an important place for many applications where the lower thermal efficiency as compared with other prime movers is not a decisive factor.

The simplicity of the gas turbine finds its best expression in the compact integrated single-shaft design featuring a single compressor-turbine rotor supported in two bearings, the whole including the combustion system being contained in a common casing structure.

The recognized need for simplicity together with reliability has been the main consideration in the design of the 9000-hp single-shaft gas turbine built by the author's company. The turbine, undergoing extensive testing in the company plant, is the first built by Clark Bros. Co. and can be used for a variety of drive applications in the compressor and pump field as well as for generator drive.

Other features of the turbine are given: (*a*) Stresses are relatively low in compressor and turbine; (*b*) good cooling of turbine disks and blade roots has been provided; (*c*) the unit has been equipped with a well-proved lubricating system; (*d*) the control system keeps the speed of the gas turbine constant at a preset value; (*e*) a temperature limiter is included which overrides the speed controller when the maximum gas temperature is reached; (*f*) a mechanical-hydraulic overspeed trip device shuts the unit down if for any reason the maximum allowable speed is reached.

Hydraulics

The Application of Internal-Gear Rotary Pumps to Viscous Liquid Service..60—Hyd-1... By S. L. Fry, L. H. Kessler, Mem. ASME, and S. E. Kotz, Fairbanks, Morse and Company, Kansas City, Kan.; and R. J. Kinnavy, The Deming Company, Salem, Ohio. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

The efficiency of a pump designed to handle light liquids is greatly reduced if it is to be used to pump viscous liquids. The purpose of this paper is to show how an internal-gear rotary pump can be altered so that it can deliver heavy liquids more efficiently.

Descriptions of the experiments on the rotary pumps of Fairbanks, Morse, and Deming Companies which were tested are given. Investigation called for determination of capacity and input power variation with respect to viscosity at rated pump speeds for different pressures and rotor clearances and determination of the limitation of pump performance.

A correlation for input power among pumps of different sizes is given. Effects of variables (speed of operation, viscosity of the liquid handled, net positive suction head available, differential pressure, and pump clearances) on the capacity of a rotary pump are presented.

Although tests of rotary pumps have been completed with relatively few runs, the idea of using rotor clearances in pump application has been proved desirable. This feature allows pumping of highly viscous liquids effectively without reducing the rated speed of the pump while the capacity of the pump is maintained.

Reduction of Turbine Runner Vibration and Noise..60—Hyd-4... By F. C. Taylor, Corps of Engineers, Dallas, Texas. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Jan. 1, 1961).

Abnormal or objectionable vibration and noise have been experienced in 12 of the 18 hydraulic turbines installed in four of the seven hydroelectric stations in the U. S. Army Engineer Division, Southwestern, Corps of Engineers. If vibration and noise level are objectionable, some effort is usually made to improve the operating conditions.

This paper is a résumé of hydraulic turbine vibration experienced in the hydroelectric stations in this section and the methods used in reducing the vibration and noise to a more satisfactory level.

These hydroelectric stations are scattered over a rather large area extending from Southern Missouri to Central Texas. All the hydroelectric installations are part of multiple-purpose projects primarily designed for flood control. This provides an operating head variation of nearly 50 per cent of the turbine design head at some projects. The 18 units are all of the Francis type with design heads varying from 59 to 190 ft.

One of the methods used to stop turbine vibration was to wedge oak struts or blocks between the buckets at about midpoint between the runner hub and the shroud ring near the discharge edge of the bucket where the turbine buckets were the source of the noise. Compressed air injected into the scroll case was used to maintain a satisfactory operating condition in one case. Reshaping bucket edges proved satisfactory as did installation of a runner bucket-bracing ring at one time.

Pressure Surges in Pipelines Carrying Viscous Liquids..60—Hyd-5... By W. T. Rouleau, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to Jan. 1, 1961).

One class of important surge problems is that in which the flow is initially steady and laminar (Poiseuille flow) and a valve downstream from a constant pressure source is suddenly closed. These problems arise, for instance, in gravity oil lines. In the past, the calculations of pressures in such lines has usually been accomplished graphically with the friction assumed to be lumped at a finite number of points.

In this paper the problem is solved by means of the separation of variables. An analytical solution which includes frictional effects is developed for pressure occurring in a pipeline when Poiseuille flow is stopped by the sudden closure of a valve.

Limitations and deficiencies of past solutions of the same problem have been overcome in the present analysis. It is shown that for most pipelines of practical interest the pressure is given by the sum of four traveling waves multiplied by a time-decaying exponential; evaluation is easily accomplished with a few simple slide-rule calculations. The computed pressures are shown to compare closely with experimental measurements.

A Jet Pump Design Theory..60—Hyd-6... By T. W. Van der Lingen, Council for Scientific and Industrial Research, Pretoria, South Africa. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to Jan. 1, 1961).

Although most aspects of jet pump operation have been successfully ana-

lyzed, a general theory, which is easily interpreted for design purposes, has not yet been formulated. It is the purpose of this paper to attempt such a formulation.

The analysis presented covers jet pumps operating on compressible fluids. The analysis is one-dimensional and is based on the momentum theory. It determines the delivery pressure of the pump, assuming that the quantities of induced and inducing fluid as well as their stagnation conditions are known.

The results for the case of constant area mixing in the pump may be obtained directly and for constant pressure mixing by an iterative method. For other cases, an approximate solution may be found by making assumptions for the pressures obtaining during the mixing process.

The analysis takes into account losses due to mixing and to a normal shock in the mixing section, if one is present. To account for friction and other losses, an over-all pressure recovery factor is introduced. This is related to the flow ratio after mixing, which is a parameter found in the analysis. The relation is determined experimentally by a series of tests made on different configuations of a variable geometry jet pump. These experiments and results are described briefly.

Results indicate that for each general pump configuration one correlating curve applies to all operating conditions. In this way, a general method for the correlation of results and for the design of jet pumps is established.

An Experimental Study of Cavitation in a Mixed Flow Pump Impeller..60—Hyd-7... By G. M. Wood, Mem. ASME, J. S. Murphy, Assoc. Mem. ASME, and J. Farquhar, Pratt & Whitney Aircraft Company, Middletown, Conn. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

Cavitation occurs in a hydraulic system when the static pressure at any point in the fluid is lowered sufficiently to permit the liquid to rupture and form vapor-filled cavities. Many experimenters have reported that initial or incipient cavitation usually takes place at a point where the local static pressure becomes equal to the vapor pressure.

This experimental evidence is contrary to the known high rupture strength of pure liquids which would require a considerable decrease in pressure below the vapor pressure to rupture and form cavities. However, the concept of cavities forming about nuclei offers a plausible explanation of why the theoretical underpressure is not realized in ordinary hydraulic systems.

A mixed flow impeller design was tested with six, five, and four vanes in a closed water loop to study the effects of cavitation on hydraulic performance, and results were compared with the work of other investigators.

Two idealized flow models for incipient cavitation were derived to illustrate limits of cavitation design. It was found that both vane blockage and solidity effects are important when designing for optimum cavitation performance.

Data showing incidence and speed effects plus the tip static pressure profiles in cavitating and noncavitating flow are also presented.

An Effect of Air Content on the Occurrence of Cavitation..60—Hyd-8... By J. W. Holl, The Pennsylvania State University, University Park, Pa. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

There are two broad types of cavitation: vaporous cavitation, the sudden expansion of a vapor bubble due to vaporization of the liquid at the bubble wall, and gaseous cavitation, the relatively slow expansion of a gas bubble due to diffusion.

This paper considers the simultaneous occurrence of vaporous and gaseous cavitation on hydrofoils.

The experimental results show that gaseous cavitation occurs at much higher ambient pressures than that for the vaporous cavitation resulting in desinent-cavitation numbers twice the minimum-pressure coefficient of the hydrofoil.

The analysis indicates that the difference between the desinent-cavitation number for the gaseous cavitation and that for the vaporous cavitation is proportional to the dissolved air content and inversely proportional to the square of the velocity.

Experiences With Hydraulic Prime-Mover Controls..60—Hyd-9... By F. R. Schleif and L. M. Johnstone, U. S. Bureau of Reclamation, Denver, Colo. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Power**; available to Jan. 1, 1961).

This paper is devoted to the prime-mover control aspects of some problems encountered by the U. S. Bureau of Reclamation with hydrogenerating units. The problems include governor instability, remote control of governor dashpot compensation, and control associated with overspeed following load rejections.

First symptoms were often complicated by contributions from voltage regulators, relays, oil pumps, or tie-line control apparatus. Attention is directed to the components or effects principally responsible.

The conclusions drawn are as follows:

1 On small, low cost hydropower units, specification emphasis should be placed upon stability rather than upon governor sensitivity.

2 Solenoid control of governor dashpot bypasses is a useful device, but one which may lead to instability under system emergencies unless adjustments are made for this condition. Dependence upon manual closing of the bypasses under emergencies is undesirable.

3 For load rejections, dependence upon the governor ball heads as the normal gate closure actuating element with speed switch actuated shutdown solenoid for backup protection affords a simple and reliable means of control. For long penstock applications, duration of overspeed is a useful criterion for effecting emergency shutdown.

Selection of the Hydraulic Turbines for the Mammoth Pool Project..60—Hyd-10 ... By H. E. Burrier, Assoc. Mem. ASME, Southern California Edison Company, Los Angeles, Calif. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Power**; available to Jan. 1, 1961).

Mammoth Pool Project, newest addition to the Big Creek Hydroelectric Development located in Central California, has a normal static head of 1100 ft which is within the operating range of either the impulse or reaction type hydraulic turbine.

An economic analysis is made for using two 88,000-hp turbines, either of the multinozzle impulse or of the reactor type. Power generation and motoring operations of each type are evaluated with the final evaluation justifying the selection of two reaction turbines for this powerhouse.

Reaction turbines also showed lower initial project cost and lower annual cost of ownership and operation.

Accelerations and Mean Trajectories in Turbulent Channel Flow..60—Hyd-3... By S. Irmay, Israel Institute of Technology, Haifa, Israel. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

The author shows that even in steady uniform turbulent channel flow there exist on the average mean accelerations and forces acting on fluid particles. These are computed from the flow equations and Laufer's data.

There exist both normal and axial mean accelerations, the latter highly negative (15g and more) in the dissipative "transition" layer near the wall, elsewhere constant.

There most river-bed load and dune-sand movement occurs. Mixing and sediment transportation are explained dynamically. Mean shear is shown to exist mainly in the dissipative layer. Mean turbulent trajectories are defined.

Pressure Oscillations in a Water-Cooled Nuclear Reactor Induced by Water-Hammer Waves..60—Hyd-2... By P. Lieberman and E. A. Brown, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

Shutdown of The Babcock & Wilcox Company's nuclear reactor water coolant pumps was expected to interrupt the steady flow of the water column in the pipe which would have resulted in sudden closure of a check valve.

Sudden closure of the check valve would have then caused water-hammer pressure pulses to travel along the approximately 60 ft of pipeline between the check valve and plenum chamber.

Thus the water-hammer waves could have caused stress loads on the check valve at one end of the pipeline, and then the discharge of pressure pulses into the plenum chamber at the other end of the pipeline.

This report analyzes the fluctuating pressure loads on the check valve and also on the components inside the plenum chamber.

The water-hammer cycle in the pipe and plenum chamber are described and damage potential in each are discussed.

Although the plenum chamber contains a great number of suspended rods, the study shows that it was possible to establish the upper bound for the pressure loading across the internal structure of the plenum chamber at various stations for determination of design criteria.

Supersonic Diffuser for Radial and Mixed Flow Compressors..60—Hyd-11... By F. Dallenbach, AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.; and N. Van Le, The Garrett Corporation, Los Angeles, Calif. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

In high-speed radial and mixed flow compressors, the flow leaving the impeller reaches supersonic values. The designer is confronted with the problem of recovering, with the maximum efficiency, the kinetic energy of this high speed flow through a diffusing system.

Presentation is made for the design concepts of a novel diffuser that handles supersonic flow at the exit of radial and mixed flow compressors. The guide vanes incorporating a V-shape at the inlet are shown to offer potentialities of a shock free deceleration of the supersonic flow.

Optimum diffusion of a high speed flow is considered. The results are applied to the design of two sets of guide vanes for the diffusing system.

The experimental evaluation of these guide vanes confirm the original conceptual thinking, with a highest diffuser performance of 0.792 at an inlet Mach number of 1.3. Effect of the blade loading and of the subsonic inlet Mach number on the guide vanes is presented. Actual performance of the diffuser in a compressor of a gas turbine is discussed.

Design of the diffusing system that incorporates a set of 29 guide vanes with a V-shape at the inlet was considered as having met the objectives of handling the supersonic flow at the exit of centrifugal impeller.

The Coring Phenomenon in the Flow of Suspensions in Vertical Tubes..60—Hyd-12... By D. F. Young, Iowa State University, Ames, Iowa. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Observation of the flow of aqueous suspensions of fine spherical glass particles in vertical glass tubes revealed a pronounced coring effect near the transition velocity between laminar and turbulent flow, in which, for upward flow all the particles collected near the center of the tube with a well-defined annulus of clear fluid adjacent to the tube walls.

The opposite effect was observed for downward flow; i.e. the particles collected along the walls of the tube. It is proposed that this nonuniform distribution of solid is due to a lateral force that acts on the particles and that this force is caused by the velocity gradient in the pipe.

A qualitative analysis is presented and a detailed study is made of the effect of coring on the head loss in upward laminar flow of suspensions. The theoretical results are checked against experimental head loss data.

Liquid-Metal Cavitation—Problems and Desired Research..60—Hyd-13... By F. G. Hammitt, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Research in liquid-metal cavitation is motivated not only by strong technological interest in applications where cavitation performance and damage effects are critical, but also by basic fundamental interest in fluids exhibiting a wide range of physical properties quite different from those of water, and thus providing a broader range of data against which to test theoretical anticipations.

The anticipated effects of the unique physical properties of liquid metals in the various areas of cavitation research are examined.

There are various physical properties of liquid metals which render research in these areas somewhat unique:

1 Low solubility of gases.
2 Existence or not of entrained gas.
3 Large Reynolds number.
4 Large volumetric proportion of vapor formed by a small reduction of pressure.
5 Increasing damaging effects with increasing fluid density.

The author concludes that at present there are little or no precise data available on cavitation performance or damage effects with the various liquid metals of technological importance. On this account, there is a strong motivation for a research effort in this area.

Observation of Cavitation in a Low Hub-Tip Ratio Axial-Flow Pump..60—Hyd-14... By M. J. Hartmann and R. F. Soltis, Lewis Research Center, NASA, Cleveland, Ohio. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

This study examines the cavitation formations in an axial-flow-pump rotor in an attempt to determine the important characteristics of a flow model which could be used to indicate the effects of cavitation.

An axial-flow-pump rotor designed utilizing blade-element techniques and axial-flow-compressor methods was operated over a range of suction pressures. The effect of a range of suction pressures on over-all performance is indicated.

Various vapor formations, observed with high-speed synchronized photographs, are discussed along with a description of vapor regions and the variation of these regions with operating conditions.

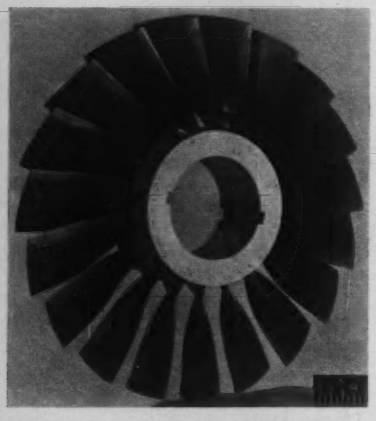
Radial surveys of the flow conditions ahead of and behind the rotor are utilized to indicate some of the changes in flow geometry resulting with vapor formations.

The data used in this study were obtained in the Lewis Water Tunnel located at the NASA Lewis Research Center.

A large part of the vapor formations observed in this type of pump is a result of the vortex bundle caused by the flow through the clearance space between the blade tips and the outer housing. The vortex bundle near the outside housing does not affect the flow a great deal until it becomes "swollen" with large volumes of vapor.

The pressure forces around the vortex bundle are such as to cause a sizable movement in the position of the vortex bundle. The rapid movement of vapor formations in the inlet to the blade passages at low inlet heads appears to be directly related to the instability of the clearance-flow vortex bundle and may contribute to instability in the pump rotor or flow system.

The major reduction in performance seems to occur when vapor is formed on the low-pressure surface of the rotor blades.



Axial-flow-pump rotor bladed with double-circular-arc blade sections used to study cavitation formations (60—Hyd-14)

The Correlation of Turbocompressor Performance With Various Gases..60—Hyd-15... By C. A. Macaluso, Assoc. Mem. ASME, Worthington Corporation, Harrison, N. J. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

In the testing and application of turbocompressors there is a need for correlating performance with various gases or conditions. It is desirable to be able to correlate design and test variables because it is not always possible to economically duplicate all design conditions in conducting a test.

With the known performance characteristics of a turbocompressor based on one gas, it is possible to predict the approximate performance with other gases.

The need for performance correlation and the advantages and limitations of the method presented are discussed from a test and application standpoint.

Parameters are derived and given on charts, with a discussion of the significant factors and effects. Experimental data are correlated, demonstrating the validity and simplicity of the method. It is proposed that similar parameters and charts be incorporated into the Power Test Codes.

Practical Stage Performance Correlations for Centrifugal Compressors.. 60—Hyd-17... By F. J. Wiesner, Jr., Mem. ASME, Carrier Corporation, Syracuse, N. Y. 1960 ASME Gas Turbine and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

Centrifugal-compressor designers, regardless of the applications of their products, are generally concerned with the same basic problem—the engineering of inexpensive stage components which, when assembled into complete units, will operate with satisfactory stability at given design flows to produce the highest possible useful pressure coefficients at the best possible efficiencies.

This paper contains some peak-performance criteria, based predominantly upon test data, which account for the effects of almost all of the significant design variables on the practical over-all performance of carefully designed centrifugal-compressor stages (having vaneless diffusers, well-matched return channels or volutes, and no inlet prerotation).

This information is expected to allow a designer to take advantage of the best possible performance history of the past in creating successful "low-cost" centrifugal-stage designs for any application.

Utilization of the basic material described in this paper is qualified by the presentation of performance correlations for the stages of two different centrifugal refrigeration compressors, each of which was operated with air and with its design refrigerant vapor.

In this portion of the study, it is demonstrated that successful correlations of centrifugal compressor-stage performance can be accomplished, even though the test and design vapors produce considerably diverse conditions of rotational Mach number and specific-heat ratio. These correlations include not only the peak-performance parameters, but the basic shapes of the characteristic curves as well.

Two-Dimensional Flow With Standing Vortices in Ducts and Diffusers..60—Hyd-16... By F. O. Ringleb, Naval Air Material Center, Philadelphia, Pa. 1960 ASME Gas Turbine Power and Hydraulic Conference paper (multilithographed; available to Jan. 1, 1961).

This paper deals with the problem of creating standing vortices in a flow and of their application to separation control. It is well known that separation of a flow usually is connected with the formation of vortices which are carried downstream by the flow, leading to a transient-flow process within the otherwise steady flow.

It is known also that behind a separation point a standing vortex can form with the effect that the vortex transport in the downstream direction is at least reduced.

The conditions for the equilibrium of two vortices in a two-dimensional flow through a duct or diffuser are derived. Potential-flow considerations and a few basic results from viscous-flow theory are used for the discussion of the role of cusps as separation control and trapping devices for standing vortices.

It is shown how proper shapes of ducts or diffusers for which standing vortices, according to the theory, exist can be computed on the basis of derived conditions. The investigation has been applied to a cusp diffuser which closely approximates that one used effectively in the wind tunnel of the James Forrestal Research Center of Princeton University.

Lubrication

Control of Oil-Whip Frequency Ratio.. 60—LubS-1... By E. H. Hull, Mem. ASME, General Electric Research Laboratory, Schenectady, N. Y. 1960 ASME Lubrication Symposium paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

Oil whip is generally considered to occur at half shaft speed although in practice the ratio is slightly less than one half. The resultant slip supplies the energy for sustaining the oil-whip motion. In some cases the oil whip will lock in with the shaft critical speed when the shaft running speed reaches twice critical. The shaft may continue to whip at its critical speed over a 2-to-1 or larger running-speed range.

Oil-whip problems might be solved if the ratio of oil-whip frequency to shaft speed could positively be controlled rather than accepting the one-half value which nature provides.

Experiments described in this paper show that a rotatable intermediate sleeve in a journal bearing will change the average oil film velocity and hence can be made to control the oil-whip frequency. The oil-whip amplitude is much reduced when the sleeve is rotated backward with respect to the shaft.

This device should allow oil-whip frequency control of shafts running at two or more times their critical speed.

A Note on the Influence of Elastic Compliance on Sliding Friction in Ball Bearings...60—LubS-2... By K. L. Johnson, University of Cambridge, Cambridge, England. 1960 ASME Lubrication Symposium paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Jan. 1, 1961).

In a recent paper by A. B. Jones, the way in which the motion of a ball in a rolling bearing is controlled by friction forces developed in zones of contract be-

tween the ball and the races is analyzed. In that study the surfaces are permitted to compress elastically so that contact is established over an elliptical area defined by the Hertz theory.

On the other hand, tangential compliance of the surfaces under the action of interfacial friction forces is explicitly excluded from consideration.

The author has recently investigated several aspects of the effect of tangential elastic displacements in the contact zone on the rolling motion of a ball. In this note, discussion is restricted to effect of tangential compliance on the friction moment resisting the motion of a ball which is spinning while rolling.

The Effect of Vibration on the Load-Carrying Capacity of Parallel Surface Thrust Bearings..60—LubS-3... By Amir Nahavandi, Westinghouse Electric Corporation, Pittsburgh, Pa.; and Fletcher Osterle, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1960 ASME Lubrication Symposium paper (multilithographed; available to Jan. 1, 1961).

According to the Reynolds equation of hydrodynamic lubrication theory, the load-carrying capacity of the parallel surface or the centrally pivoted pad thrust bearings, with a lubricant of constant viscosity and density is zero. It is well known that this result is not in agreement with the observed performance of those thrust bearings. It has been shown experimentally that the parallel surface thrust bearings can support loads of considerable magnitude. To explain this apparent paradox, several theories have been advanced in the literature from time to time.

The purpose of this paper is to investigate the possibility that small oscillations of the slider relative to the bearing inherent in the dynamics of thrust bearings can develop a hydrodynamic film and produce a significant load capacity. This proves to be the case; thus vibration is a factor contributing to the performance of parallel surface and centrally pivoted pad thrust bearings.

Two types of vibration are considered: wobble and bounce. It is shown that wobble alone can develop a hydrodynamic oil film and a load-carrying capacity of considerable magnitude.

The solution to the problem is obtained first analytically under simplifying assumptions analogous to the "narrow bearing" theory of journal-bearing lubrication and then numerically on an IBM-704 digital computer using the full Reynolds equation in finite-difference form. The results of these alternate methods of solution are found to be in close agreement for the bearing geometries encountered in practice. The wobble analysis suggests a novel form of thrust bearing which might have considerable merit.

Automatic Techniques

Metal-Forming Under Electronic Sequencing..60—Aut-1... By E. V. Crane, Mem. ASME, and F. P. Fehn, E. W. Bliss Company, Canton, Ohio. 1960 ASME-AIEE-IRE Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1961).

Progress is being made in the application of electronic-sequencing principles to varied control functions for the range of metalworking equipment built by different divisions of the authors' company. Discovering where control of this sort can be advantageous is a part of the program. Surmounting the language barrier of electronics has been no small part of it.

Servo control is perhaps the key idea. In this, the control of large masses and forces with ever smaller and smaller currents and components is only a part of the idea. More important are the almost human weighing and evaluating of the changing circumstances and making the needed compensations from instant to instant.

Feedbacks must also be understood. In servo control, a variety of devices feed back to the control specific signals described as digital.

The applications are scattered among mechanical and hydraulic presses, heavy machine tools, and rolling mills. An explanation is given of the basic language used and applications of sequencing principles in the metal-forming industry.

Numerical Control Developments..60—Aut-2... By R. G. Chamberlain, Giddings and Lewis Machine Tool Company, Fond du Lac, Wis. 1960 ASME-AIEE-IRE Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1961).

The numerical control of machine tools is a new development that is greatly affecting the metalworking industry. The airplane industry adopted numerical control of machine tools soon after it was first displayed in 1955 and since that time it has been used widely.

Two systems of control—continuous path, and discrete control—have been developed. The difference in the two systems lies in the amount of control. The continuous-path monitors the position of the tool constantly while, generally, the discrete only makes sure that certain endpoints are achieved.

Savings resulting from numerical control have been significant; at the same time, accuracy has been increased. Another benefit is that production lead times are shortened even though programming is involved in each case.

New fields of application of these control systems to such machine tools as the vertical boring mill, vertical turret lathe, horizontal drill, and positioning table are described in the paper.

Automatic Inspection and Assembly..60—Aut-3... By H. L. Boppel, Sheffield Corporation, Dayton, Ohio. 1960 ASME-AIEE-IRE Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1961).

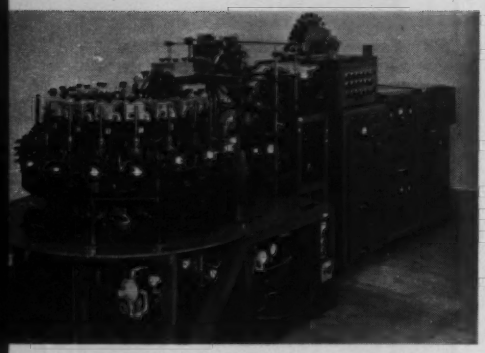
The growing interest in automation demonstrates the almost universal desire of this generation to accomplish a maximum result with a minimum effort. Laziness may be the mother of invention, but it cannot be said that the development of automation is its companion as the personnel responsible for the development of the automated factory must be, to say the least, industrious, informed, and alert.

Co-operative understanding or "team spirit" between the designer and builder of an automatic inspection and assembly system and the user is essential in creating a system that will function accurately and economically through long periods of operation.

This same co-operative spirit should extend to component suppliers. Gaging, controlling, and qualifying of mass produced parts can be performed more effectively with automatic machinery than is possible under manual operation.

Covered in the paper are post-process control, automatic inspection and assembly, automatic selection gages, monitoring systems, and tool detection.

In this typical automatic inspection and assembly machine, ball bearings are automatically gaged, classified, and matched assembled (60—Aut-3)



This automatic machine was developed to fabricate, assemble, and test a telephone product, the dry-reed switch (60—Aut-4)

Techniques and Economic Considerations Affecting Automatic Assembly of Telephone Products..60—Aut-4... By J. F. Stoltz, Western Electric Company, Chicago, Ill. 1960 ASME-AIEE-IRE Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1961).

This paper presents a discussion of some of the factors which affect the feasibility of automatic manufacture and assembly of telephone products at the author's company.

Reference is made to the economic criteria used by Western Electric Company in determining feasibility and to the role of some of the newly developed techniques.

The influence of product design is discussed with examples of tandemized operations on wire and cable products, automation of the wire-spring relay, and of the dry-reed switch.

It is emphasized that perhaps the most important single aspect affecting the feasibility of automatic assembly in nearly any industry is the design of the product itself.

Textiles

Maintenance Records Simplified..60—Tex-1... By J. H. Boddie, Mount Vernon Mills, Inc., Tallassee, Ala. 1960 ASME Textile Engineering Conference paper (multilithographed; available to Jan. 1, 1961).

The analysis of facts accumulated by plants from operating experience is the basis upon which all progress in production efficiencies are made. The systems of recording data can often be monotonous and thereby become ineffective due to the routine methods generally employed.

This paper describes briefly how one textile plant used an innovation in its record system to create interest in improving its maintenance program. This system has merit from the following standpoints: Simplicity, economy of time to keep records and space to keep them; records number and costs of replacement parts; assists in the evaluation of old model machines as against later designed machines from a maintenance standpoint; assists in the evaluation of machine overhaul frequencies; assists in solving lubrication problems; and points out improper machine operations.

The system is described and analyzed and requisite plant conditions are given. The author emphasizes the value of examining present methods of keeping records with a view toward making them more effective instruments of the maintenance program.

Textile Waste Treatment—What to Do About It..60—Tex-2... By J. L. Brown, Jr., Cannon Mills Company, Kannapolis, N. C. 1960 ASME Textile Engineering Conference paper (multilithographed; available to Jan. 1, 1961).

The problem of stream pollution is increasing every day. New and more economical methods of textile waste treatment are needed to combat this ever-increasing problem.

This paper discusses the textile-waste problem of the author's company and the methods employed to arrive at a solution.

Waste being treated consists of domestic sewage from the mills and mill village and certain wastes from the bleachery and slasher rooms, chiefly starch, and a three per cent caustic solution used as a cleaning agent.

Results of a two-year study on the wastes showed that treatment could best be effected if wastes were segregated at the bleachery and transported to the treatment plant in separate pipelines. The starch was to be treated immediately on arrival at the plant and the caustic waste was to be stored in a lagoon and treated on a seven-day basis.

The waste treatment plant consists of the following units: a caustic storage lagoon, primary clarifiers, trickling filters, secondary clarifiers, chlorine contact tank, sludge digesters, and vacuum filtration of sludge. Since installation three years ago changes have been made that have greatly improved the efficiency of the plant. The problems occurring and the modifications made in the system are described.

Railroads

The Slippery Spot Concept of Adhesion..60—RR-2... By J. C. Aydelott, General Electric Company, Erie, Pa. 1960 ASME-AIEE Railroad Conference paper (multilithographed; available to Feb. 1, 1961).

Slipping always has been and probably always will be a vital consideration in railroading. In attempts to solve this problem, adhesion has been measured and measured again, each observer hoping

Availability List— Unpublished ASME Papers

A number of papers and reports, not preprinted or published, were presented at ASME Meetings. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 50 cents per page. Microfilm copies are available at a cost of $2 for 40 pages or fraction thereof.

The following papers recently have been placed on file in the Engineering Societies Library:

1958 Annual Meeting

The Use of Simulation in Management Analysis—A Survey and Bibliography, by D. G. Malcolm

1959 ASLE-ASME Lubrication Conference

Frictional Characteristics of Flat Sliding Bearings, by C. O. Graves

1959 Annual Meeting

The Calculation of Incompressible Flow Through Turbine Cascades, by H. F. Bueckner and H. C. Schnackel

Shortcomings vs. Requirements of Engineers in Management, by T. S. Coldewey

Coal for Power, by A. R. Matthews

Engineers Are People? by M. Long

Applied Mechanics Dinner Address: Ascendant Role of the Engineer, by J. V. Charyk

1960 Gas Turbine Power and Hydraulic Conference

The "Total" Application of Gas Turbines, by C. R. Apitz

A New 10,500-Hp Gas Turbine, by R. L. Boyer

1960 American Power Conference

Measurement of Density and Moisture in Large Coal Storage Files, by B. B. Bonadic, A. J. Grimes, and H. I. Lamphier

The Factory-Fabricated Coal-Fired Boiler, by L. F. Deming

Slag Tap Boiler Performance Associated With Power-Plant Fly Ash Disposal, by H. M. Rayner and L. P. Copian

that where others had failed he would be able to nail it down once and for all. The fact is that no adhesion curve ever drawn is a guarantee against slipping, in spite of the repeated attempts that have been made to find an ultimate answer.

In this paper speed recorder tapes showing slips, both self-correcting and automatically corrected, are correlated with adhesion measurements taken by hand. The concept that low adhesion occurs intermittently is developed and it is shown that there are stretches of good adhesion interspersed between the slippery spots.

Good slip-detection and correction means, such as those described, enable a locomotive to make use of prevailing stretches of good adhesion and effectively develop high horsepower per driving axle to move trains economically over a railroad.

ASME TRANSACTIONS

The May, 1960, issues of the Transactions of the ASME—*Journal of Heat Transfer* and *Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members; $3 to nonmembers)—contain the following:

Journal of HEAT TRANSFER

Vol. 82 • Series C • No. 2

77 Heat Transfer From Transverse and Yawed Cylinders in Continuum, Slip, and Free Molecule Air Flows, by L. V. Baldwin, V. A. Sandborn, and J. C. Laurence. (58—A-202 and 59—HT-5)

87 Magnetohydrodynamic Effects Upon Heat Transfer for Laminar Flow Across a Flat Plate, by R. D. Cess. (59—HT-14)

94 Conical Turbulent Boundary Layer Experiments and a Correlation With Flat Plate Data, by W. S. Bradfield. (59—HT-6)

101 The Influence of Free Stream Turbulence on the Local Heat Transfer From Cylinders, by R. A. Seban. (59—HT-3)

108 Heat Transfer to Fully Developed Laminar Flow in a Circular Tube With Arbitrary Circumferential Heat Flux, by W. C. Reynolds. (59—HT-13)

113 Steam Slip—Theoretical Prediction From Momentum Model, by S. Levy. (59—HT-15)

125 Pressure Drop and Heat Transfer in a Duct With Triangular Cross Section, by E. R. G. Eckert and T. F. Irvine, Jr. (59—HT-10)

139 Heat Transfer in Flow Through Rotating Ducts, by C. Y. Kuo, H. T. Iida, J. H. Taylor, and F. Kreith. (59—HT-12)

TECHNICAL BRIEF

152 Comparison of Turbulent Heat-Transfer Results for Uniform Wall Heat Flux and Uniform Wall Temperature, by R. Siegel and E. M. Sparrow.

Journal of ENGINEERING FOR INDUSTRY

Volume 82 • Series B • Number 2

87 Simplified Approach to Understanding the Suction Problems for Reciprocating Mud Pumps, by W. E. Liljestrand. (59—Pet-23)

93 Prevention of Sulfide-Stress Cracking in Sour-Condensate Well Equipment, by W. J. McGuire and L. W. Vollmer. (59—Pet-36)

103 Overstrain Tests on Thick-Walled Cylinders, by S. M. Jorgensen. (59—Pet-1)

122 An Analytical Study of Drill-String Vibration, by J. J. Bailey and I. Finnie. (59—Pet-15)

129 An Experimental Study of Drill-String Vibration, by I. Finnie and J. J. Bailey. (59—Pet-16)

136 The Theory of the Ideal Design of a Compound Vessel, by S. J. Becker and L. Mollick. (59—A-125)

143 The Strength of Thick Cylinders Subjected to Repeated Internal Pressure, by J. L. M. Morrison, B. Crossland, and J. S. C. Parry. (59—A-167)

154 The Interaction of Textile Structures and High-Speed Textile Processes, by H. M. Morgan. (59—A-115)

159 Effect of Transient Loads on the Refrigerated-Space Temperature of a Cooling Complex, by C. F. Kayan. (59—A-181)

167 Uniform Two-Way Orientation of Plastic Films, by M O. Longstreth and Turner Alfrey, Jr. (59—A-113)

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Pamphlet copies of numbered ASME technical papers are obtainable from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. **Please order only by paper number;** otherwise orders will be returned. Papers are priced at 40 cents to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

Note: No digests are made of ASME papers published in full or condensed form in MECHANICAL ENGINEERING.

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60—GTP-6	60—Hyd-6	60—Aut-3
60—GTP-7	60—Hyd-7	60—Aut-4
60—GTP-8	60—Hyd-8	60—Tex-1
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60—GTP-10	60—Hyd-10	60—RR-2

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COMMENTS ON PAPERS

ASME Boiler and Pressure Vessel Code

Comment by P. J. Bier[1]

TWO INTERESTING articles[2,3] present the high lights of the development and operation of the ASME Boiler and Pressure Vessel Code. The first article shows that the Code became necessary for the protection of life and property in an expanding industry. Although at first the rules of the Code were to apply only to steam boilers, the Code was later expanded to include the construction of unfired pressure vessels used in the oil and chemical industries. Eventually, two different Codes were published to cover the specific requirements of each industry. These were the ASME Code prepared primarily to serve the requirements of the power and chemical industries, and the API-ASME Code to serve the petroleum industry. This unnecessary duplication, however, became apparent and the codes were combined into the present ASME Code by mutual consent in June, 1956, becoming effective on Jan. 1, 1957.

While the present ASME Code serves the pressure-vessel field quite adequately, it does not cover the specific requirements of large pressure pipelines such as power penstocks, pump lines, and other water-supply lines. There are problems of fabrication, welding, stress relieving, supports, installation, and the like which are not found in the construction of enclosed self-contained pressure vessels. Consequently, many departures are necessary from the Pressure Vessel Code if it is to serve the design and construction of large pressure pipelines.

A new addition to the Code should be prepared to fulfill that purpose. It may not be desirable to cover the subject in the same issue with pressure vessels as it would tend to increase the size of the already large volume beyond practicable limits. A separate booklet, preferably of pocket-size format which could be carried along by inspectors during their inspection work, would, perhaps, be the best solution of this problem.

The desirability for a special Code for pressure pipe construction became evident last year and this writer has found it expedient to prepare a brief pamphlet covering the subject for the use of designers and inspectors. The issue was based on the ASME Code, using, with the approval of ASME, applicable data from the last edition. Only a limited number of copies of the pamphlet were issued for local use.

With the great increase in water-supply projects throughout the world the construction of large pressure pipelines is increasing from year to year. Much of this development is taking place in underdeveloped countries and is, in many cases, financed by the World Bank, and planned and constructed by foreign engineers and contractors. Being ventures of international scope the question arises what rules or codes should be followed in the design and construction of such pressure pipelines. Some European countries have their own codes which are at variance with the ASME Code. Considerable indecision and confusion may result unless there is a recognized international code which will be followed all over the world.

Imagine receiving bids on pressure pipe from a foreign company in which the bidder offers to supply pipe which was to be fabricated in accordance with a code used in his country. Unless the contracting agency is familiar with this code it will not be able to evaluate such bids in comparison with others and decide on an award of contract. The paper[2] by J. H. Harlow mentioned an attempt made by the International Organization of Standardization after World War II to unify boiler codes on a world-wide basis. This great idea should be revived and carried to conclusion not only for boilers and pressure vessels but also for pressure pipes.

In this period of increasing international co-operation along all lines of activities the standardization of engineering and construction problems should not be neglected. It is suggested, therefore, that the ASME Boiler and Pressure Vessel Code Committee be authorized to take steps for a discussion of this matter with the ISO so that it may be carried further on an international basis as soon as possible.

Author's Closure

In connection with the comments by P. J. Bier concerning my article,[2] I would like to make two observations. First, the ASA Code for Pressure Piping B31.1 covers quite adequately the problems of piping which Mr. Bier mentions; and second, the International Standards Organization activity in connection with an International Boiler Code is a continuing thing in which the ASME Boiler and Pressure Vessel Committee has, and will continue to maintain, an active interest.

J. H. Harlow.[4]

Author's Closure

Only after many years of work by many varied interests, utilizing the services of many engineers, has the ASME Boiler and Pressure Vessel Code attained the status of a standard enforced by the laws of most of the States and all the Provinces of Canada.

The large number of boilers and pressure vessels manufactured in shops in all sections of the United States and Canada indicates the need for uniformity. This is especially true of the storage pressure

[1] Consulting Engineer, Denver, Colo. Mem. ASME.

[2] J. H. Harlow, "How the Code Originated," MECHANICAL ENGINEERING, July, 1959, vol. 81, pp. 56–58.

[3] E. M. Kloeblen, "The Code in Operation," MECHANICAL ENGINEERING, July, 1959, vol. 81, pp. 58–59.

[4] Chief Mechanical Engineer, Philadelphia Electric Company, Philadelphia, Pa. Fellow ASME.

vessels at consumer locations, used for industrial gases distributed in bulk.

The design and construction of large-pressure pipelines such as power penstocks, pump lines, and other water-supply lines involve a wide variety of field fabrication and operating considerations. Because the problems are not the same for each project, the practice has been to tailor the design to the project and its environment. Basic design factors varying from four to one, to two and one half to one (ultimate strength of the material to major service stress) are not uncommon. Any standards would be limited to materials selection and fabrication procedures. The design factors must be left to the engineers. Such national and international standards would take many years of effort and be of quite limited scope.

E. M. Kloeblen.[5]

[5] Assistant Manager, Safety Codes Department, Linde Company Division, Union Carbide Corporation, New York, N. Y. Mem. ASME.

Feedback . . . Consumer to Factory

Comment by Jay W. Forrester[6]

THIS paper[7] correctly states the general proposition that industrial systems are information-feedback systems whose characteristics are dependent on the structure and the policies of the system.

One must, however, be cautious about using the simple intuitive and arithmetical analysis of this paper for studying the behavior of such systems. As treated in my paper, "Industrial Dynamics—A Major Breakthrough for Decision Makers," *Harvard Business Review*, vol. 36, July-August, 1958, the system discussed in McGarrah's paper requires some 60 nonlinear differential equations for an adequate system representation. In the actual systems, the time delays are of the distributed type rather than the discrete type used in the examples in the paper.

In the absence of a consideration of noise and uncertainty in the information flows, it is not clear that the suggested information feedback from the consumer to the factory would, indeed, create an improved system.

On the whole, the paper conveys the correct impression that analysis of industrial systems will become possible, that from this analysis improved system behavior can be obtained, and that an understanding of the dynamics of industrial systems will provide an underlying science as a foundation for the teaching and the practice of the art of management.

However, a caution should be inserted against creating the impression that this understanding will come casually and easily. The management systems of interest contain from 10 up to 100 times as many important variables as are found in most mechanical feedback systems which have been analyzed thus far. Furthermore, the management systems are apt to be much more dependent for their important behavioral characteristics on nonlinear phenomena than are most electrical, chemical, and mechanical servomechanisms. The arithmetical and intuitive analysis used in this paper has proved inadequate even for the more simple, linear, engineering systems. One must therefore approach industrial and economic systems with an awareness of the principles of information feedback systems, with modern computers to simulate systems that lie beyond the realm of explicit mathematical solution, and with the respect due a great opportunity in a new frontier of systems engineering.

[6] School of Industrial Management, Massachusetts Institute of Technology, Cambridge, Mass.

[7] R. E. McGarrah, "Feedback . . . Consumer to Factory," MECHANICAL ENGINEERING, vol. 82, January, 1960, pp. 41–43.

Author's Closure

Professor Forrester properly warns that my paper[2] is limited to stimulating readers' intuitive interest in the notion of business as a dynamic system; indeed, I had no intention other than to incite a change from a static to dynamic (and, I think, a more useful) concept of business organization and operation.

That, realistically, the time-delays are of the distributed type rather than discrete is probably true, although I believe there may be a certain "batching" of information and product flows which may conceivably manifest discrete properties to occurrences of these delays. In holding to simple expository purpose, I begged the question of the probabilistic nature of these delays. I have not had the opportunity to experiment with explicit considerations of noise and uncertainty in the information flows from consumers to the factory. But I can see no reason why noise and uncertainty in a direct, consumer-to-factory feedback loop should adversely affect the behavior of the system. I should think that the earlier management is informed of changes in the rate of consumer demand, the better its decisions can be to control the response to these changes, even though noise and uncertainty are distributive.

I am glad Professor Forrester stresses the nonlinear behavioral characteristics of production-distribution systems. In actual business situations, I think the point, when it becomes economically feasible and even necessary to use modern computers to simulate these systems, probably remains a matter of a manager's judgment.

R. E. McGarrah.[8]

[8] Associate Professor of Business Administration, Harvard University Graduate School of Business Administration, Boston, Mass.

BOOKS RECEIVED IN LIBRARY

The Engineering Index—1959

Edited by Carolyn M. Flanagan, et al. Seventy-fifth Edition. 1960. The Engineering Index, Inc., New York, N. Y. 1600 p., 7×10 in., bound. $70, postage paid. Publications of scientific, engineering, and technical societies; engineering and industrial periodicals; and reports of government bureaus, engineering experiment stations, universities, and other research organizations are reviewed. Not necessarily all articles contained in these publications are indexed. Selection is made on the basis of articles dealing with the science and art of engineering. Articles on pure science, economics, commerce and trade, editorials, news items, notices of meetings, trade announcements, and the like, are included only if these are considered of primary importance. The Index contains a 12-page list of technical publications received by the Engineering Societies Library and reviewed by The Engineering Index; 96 pages are devoted to an author's index. Of the 1700 technical publications reviewed, 699 come from 44 countries outside the United States. The following is a tabulation of the foreign publications and the countries from which they emanate:

England, 218; Germany, 89; France, 58; USSR, 41; Canada, 34; Japan, 26; Australia, 23; Belgium, 23; Sweden, 23; Italy, 18; Switzerland, 18; India, 17; The Netherlands, 14; Austria, 12; Argentina, 11; Poland, 11; South Africa, 11; Denmark, 9; Spain, 7; Czechoslovakia, 5; Mexico, 4; Peru, 4; China, 3; Brazil, 2; Finland, 2; New Zealand, 2; Norway, 2; Portugal, 2; Romania, 2; Scot-

land, 2; The Philippines, 2; Venezuela, 2; Yugoslavia, 2; Chile, 1; Cuba, 1; Greece, 1; Hungary, 1; Iceland, 1; Ireland, 1; Israel, 1; Pakistan, 1; Turkey, 1; Uruguay, 1; and Wales, 1.

This volume is comprehensive, covering all applications of engineering methods and concepts to industry, agriculture, mining—the entire economy. No other abstracting service covers world-wide technological literature as extensively. Libraries—public and special—industrial firms, trade associations, government bureaus, schools and universities, and many individual engineers and technological specialists subscribe to keep informed, or for reference and bibliographical help on specific projects. The Engineering Index contains 249 "field of interest" divisions and more than 30,000 references.

Fliesspressen von Stahl

By Heinz D. Feldmann. 1959, Springer-Verlag, Berlin, Germany. 208 p., $6^1/_2 \times 9^1/_2$ in., bound. $7.56. This volume on cold extrusion of steel is stated to be the first complete book treatment of the subject. It aims to acquaint both the practical engineer and designer, as well as the student, with the fundamentals and application possibilities of the process. It deals with such topics as steel grades capable of extrusion; heat-treatment; development of crystalline structure; effect of cold extrusion on structure and on mechanical properties, etc.

Fracture

Edited by B. L. Averbach, and others. 1959, John Wiley & Sons, Inc., New York, N. Y. 646 p., $6^1/_2 \times 9^1/_2$ in., bound. $17.50. The papers presented at an international conference on the cleavage, ductile, fatigue, and high-temperature atomic mechanisms of fracture of metals, ceramics, and polymers, held at Swampscott, Mass., in April, 1959, form 27 chapters of this book. Each chapter includes an abstract of its paper and intensive references, and most also include discussion of the content. A valuable feature of the book is the summary of the current status of experiment and theory and of the needs of future research, which forms the first chapter.

Handbook of Industrial Research Management

Edited by Carl Heyel. 1959, Reinhold Publishing Corporation, New York, N. Y. 513 p., $6^1/_4 \times 9^1/_2$ in., bound. $12. This volume provides a guide for the organization, evaluation, and control of industrial research. For those in top management the book can be a yardstick and a guide to controlling and evaluating this costly operation; for directors of research, administrative problems are dealt with; for their executive directors, the day-to-day details and responsibilities are presented; and for financial executives there are papers on accounting and budget control of the research function. The final chapter discusses government contracts.

Handbuch Des Stranggiessens

By Erhard Herrmann. 1958, Aluminum-Verlag GmbH Düsseldorf, Germany. 916 p., $7^1/_2 \times 10$ in., bound. DM300.00. A comprehensive handbook on continuous casting which presents in a single volume not only the experiences of the author's own company, the Aluminum-Industrie A.G., but also such other information as has appeared in the published literature from the very beginning of continuous casting. There is a bibliography divided by language as well as an extensive list of some 3300 patents. The foreword, table of contents, and index are in German, English, and French, and a trilingual glossary is appended.

Introduction to Rubber Technology

Edited by Maurice Morton. 1959, Reinhold Publishing Corporation, New York, N. Y., 547 p., $6^1/_2 \times 9^1/_2$ in., bound. $10. This compilation of selected lectures from rubber groups throughout the country introduces the chemical fields of the rubber industry—the synthetic rubbers and the allied synthetic polymers—to technologists, and to those in sales and service activities. Among the synthetic rubbers discussed are butadiene-styrene, nitrile and polyacrylate, butyl, and silicone rubbers, neoprene, polysulfide polymers, and reclaimed rubber. Vulcanization and its accelerators, antioxidants and antizonants, plasticizers and softeners, carbon black, and nonblack compounding ingredients are also expounded in detail.

Linear Circuit Analysis

By B. James Ley and others. 1959, McGraw-Hill Book Company, Inc., New York, N. Y., 567 p., $6 \times 9^1/_2$ in., bound. $12.50. The fundamentals of linear, lumped circuit theory are presented, including the formulation of network equations and their solution in the time domain by classical methods or in the frequency domain by Fourier & Laplace transforms. Electrical and mechanical analogs are treated in order. To show a general method of analysis specified by simultaneous integrodifferential equations. The text also deals with topology, the cut-set method of writing circuit equations, the use of matrices in their formulation, scale factors in analogs, and mechanical circuit theorems.

Mechanisms and Motion

By K. H. Hunt. 1959, John Wiley & Sons, Inc., New York, N. Y. 114 p., $5^3/_4 \times 9$ in., bound. $4.25. The problems of kinematics are presented in a manner which emphasizes the relationship between the analysis of linkage geometry and the practical design proposed. Vector operations and the conventions and principles governing relative motion of rigid bodies form the background for later chapters on the analysis of mechanisms, the general principles of constrained motion, and mechanisms in three dimensions.

Midwestern Conference on Fluid Mechanics, Proceedings, 1959

Published 1959 by the University of Texas, Austin, Texas. 465 p., $5^1/_2 \times 8^3/_4$ in., bound. $12.50. Aerodynamics, heat transfer, characteristics of hypersonic and tangent flow, shock-waves boundary-layer conditions, lubrication, and wave motions are the general areas covered by the 30 papers in this volume. Specifically, papers deal with such topics as secondary flow in straight open channels, theoretical and experimental study of heat transfer by cellular convection in the presence of impressed magnetic fields, an extended Reynolds analogy, and scale effects in turbulent shock-wave boundary-layer interactions.

Midwestern Conference on Solid Mechanics, Proceedings, 1959

Published 1959 by the University of Texas, Austin, Texas. 530 p., $5^1/_2 \times 8^3/_4$ in., bound. $12.50. Papers in this volume indicate the directions of analytical research and fundamental experiments in the field of solid mechanics. General areas covered include shell theory and shell deformation, buckling, thermal stresses, wave mechanics, vibration, and strain. The 29 papers included range from basic topics such as the impact of cylinders of different areas and the collapse load of a spherical cap to specialized treatments of spin dynamics of a thrusting rocket in a vacuum and bending waves in free-free beams.

Nature and Properties of Engineering Materials

By Zbigniew D. Jastrzebski. 1959, John Wiley & Sons, Inc., New York, N. Y. 571 p., $6 \times 9^1/_2$ in., bound. $11. Here is information on basic materials for specific engineering applications. A consideration of the basic concepts of interatomic and intermolecular forces and their relationship to the structural characteristics of crystalline and amorphous materials forms the basis of the discussion of the phenomena of diffusion, crystallization, phase transformation, and phase equilibria. Then follows a more specific development of the characteristic physical properties of metals and ceramics, electrical and magnetic properties of materials, corrosion, friction and lubrication, concrete, and protective coatings.

Nondestructive Testing Handbook

Edited by Robert C. McMaster. 1959, The Ronald Press Company, New York, N. Y. 2 vols., $6^1/_2 \times 9^1/_2$ in., bound. $24. A comprehensive reference work on the major methods of nondestructive testing: The measurement of significant properties, detection of discontinuities, and prediction of performance capabilities without impairing serviceability. It combines principles and data to provide a full explanation of test methods and applications, equipment and techniques, and to act as a guide for the interpretation of the tests to evaluate the serviceability of the test objects. x-ray processes, electrified-particle and magnified-particle tests, ultrasonic tests, liquid-penetrant tests, and visual techniques are among the major areas covered. Several comparatively new techniques such as immersion ultrasonic testing, isotype radiography, and eddy current testing are presented as well. The book can be used as a basis for setting up test programs.

Notes: Basic Engineering Sciences

By C. E. Harrington. Fourth Edition. Published 1959 by author, 45 Elk Street, Springville, N. Y. 169 p., $8^1/_2 \times 11$ in., paper. No price given. A brief review of engineering fundamentals with answers to 200 problems, asked in the New York State Board Examinations for the Professional Engineering License, are contained in this book. This fourth edition has been enlarged to include several new subjects and much of the text has been rewritten. It has been found helpful as a reference book for those working in industry as well as for home study for the Board examinations.

Nuclear Fuel Elements

Edited by Henry H. Hausner and James F. Schumar. 1959, Reinhold Publishing Corporation, New York, N. Y. 409 p., $6^1/_4 \times 9^1/_4$ in., bound. $12.50. Papers presented by U. S. and European scientists at the First International Symposium on Nuclear Fuel Elements (January, 1959) form the basic part of this book on the development, design, and fabrication of nuclear fuel elements. Topics covered include element standardization and fabrication cost-analysis, as well as the physical and operational characteristics of elements. Appendixes offer typical specifications and an extensive bibliography.

Nuclear Technology for Engineers

By R. Hobart Ellis, Jr. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 248 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.50. This guide covers four major areas of nuclear engineering —radiotracer technology, radiation, fission energy, and nuclear fusion. An explanation of the structure of the atomic nucleus and the disintegration of unstable nuclei is followed by

the uses which modern technology makes of these properties. Low-level radiation, or radiotracer work, and high-level radiation are treated with regard to sources, effects, uses, and doses. Fission reactors and the engineering problems of building a reactor, a discussion of the different types of reactors, and a description of fusion, plasma physics, and fusion devices conclude the volume.

Physical Metallurgy

By Bruce Chalmers. 1959, John Wiley & Sons, Inc., New York, N. Y. 468 p., $6^1/_4 \times 9^1/_4$ in., bound. $12.50. Physical metallurgy is treated in terms of atomic processes and interactions, developing a comprehensive physical framework for metals and alloys. Experimental information is compared with the theoretical expectation in order to develop physical concepts that can be applied to real cases. Structure, properties, imperfections, deformations, change of state, and transformations are dealt with in turn, with the underlying theme that the behavior of a metal is determined by its properties and environment, and that these have been determined by its basic structure, chemical composition, and history.

Physics and Chemistry of the Earth, Vol. 3

Edited by L. H. Ahrens, and others. 1959, Pergamon Press, New York, N. Y. 464 p., $6^1/_2 \times 10$ in., bound. $15. Two general themes, "origin" and "distribution," are continued in this third volume of an annual series surveying progress in the interpenetrating fields of physics, chemistry, mineralogy, and astronomy. An origin theme is carried on in a discussion of the types of nuclear reactions which may become involved during the formation of the elements. Study of the distribution of the elements continues in a survey of uranium and thorium. Other topics discussed include the silicate melt systems, the electrical properties of the earth's interior, geochemistry in the USSR, and Palaeoclimatology or the climate of the past.

Plasma Physics and Thermonuclear Research, Vol. 1

Edited by C. Longmire and others. 1959, Pergamon Press, Inc., New York, N. Y. 612 p., $6 \times 9^1/_2$ in., bound. $15. This first volume of Series XI of the edited "Proceedings" of the Second International Conference on the Peaceful Uses of Atomic Energy, 1958, is in four parts, each composed of individual papers. Part one constitutes a survey of recent work in Germany, Sweden, England, USSR, and the U. S. A. on controlled thermonuclear reactions. Part two examines particular devices used, such as the "Stellarator," the "Magnetic Mirror," "Plane Shock," and the "Pinched Discharge," and forms the major part of the book. The theoretical papers of part three discuss plasma equations and radiation, and hydromagnetic equilibria, and part four deals briefly with some miscellaneous devices.

1958 References on Fatigue

Published 1959 as Special Technical Publication No. 9-J by the American Society for Testing Materials, Philadelphia, Pa. 76 p., $8^1/_2 \times 11$ in., paper. $3.50. This 1958 list of references to articles dealing with fatigue of structures and materials follows the plan of eight similar lists published from 1950–1957 by the ASTM. References are arranged alphabetically by author on mimeographed sheets which can be cut apart for filing if desired. Source citations are clear and complete and brief abstracts are included where available. Criteria of selection for inclusion in the list, and thus comprehensiveness, are not apparent.

LIBRARY SERVICES

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Rocket Propulsion

By Marcel Barrère, and others. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 829 p., $6 \times 9^1/_2$ in., bound. $27. The technique of solid and liquid-propellant rocket motors and complex instability problems are fully treated here, for both the engineer and the specialist in the field. Now including results of recent experimental work done at the ONERA, this translation has also been further extensively rewritten and revised from the original. In addition to dealing extensively with propellants, the aerothermochemistry of the products of combustion, motor types and nozzles, and the external ballistics of rockets are thoroughly covered.

Space Flight, Vol. 1

By Krafft A. Ehricke. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 513 p., $6 \times 9^1/_2$ in., bound. $14.50. The concept of space flight and the environment in which it will take place is introduced through its historical aspects, followed by discussion of energy requirements in relation to gravitational and orbital conditions in the solar system, radiation and particles, and planetary and satellitcry bodies in space. The second part of this work treats celestial mechanics from the viewpoint of the astronautical engineer. Summarized and tabulated data are included for use in research and development work, design, and systems analysis. The second and third volumes of "Space Flight," to follow shortly, will discuss space dynamics and operations.

Symposium on Microscopy

Published 1959 as Special Technical Publication No. 257, by the American Society for Testing Materials, Philadelphia, Pa. 165 p., $6^1/_4 \times 9^1/_4$ in., bound. $4.75. The papers of this symposium on light and electron microscopy supplement the 1952 "Symposium on Light Microscopy" (ASTM-STP No. 143). Recent advances in microscopy are revised in a brief introduction, which also indicates that refinements and improvements are needed in sample handling and preparation techniques. Nine papers form the body of the symposium, discussing phase and interference microscopes; performance characteristics of objectives, eyepieces, and illuminators; and microscopy in the optical, petroleum, ceramic, mineral, and textile industries.

Systems of Units: National and International Aspects

Edited by Carl F. Kayan. 1959, American Association for the Advancement of Science, Washington, D. C. 297 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.75. International exchange of technical information would be greatly promoted by a more nearly universal system of units. To focus attention on the growing problems of unit usages, this symposium presents authoritative discussions from the U. S. and abroad dealing with English versus metric units and the absolute versus the gravitational (technical) system. Treatment of the MKSA system also is included.

Tantalum and Niobium

By G. L. Miller. 1959, Academic Press, Inc., New York, N. Y. 767 p., $6^1/_2 \times 8^3/_4$ in., bound. $21. This handbook on tantalum and niobium contains all available chemical and metallurgical information and provides text-indexed references to published words from the time of von Bolton (ca 1905). The sixth in a series of such publications dealing with the rarer metals, it gives full coverage to chemical processing, consolidation techniques, reactions with chemicals, gases and liquid metals, physical and mechanical properties, and production and applications of the metals, their alloys and important compounds. All information included has been analyzed by specialists. Comprehensive author and subject indexes are included.

Value Engineering 1959

Published 1959 by Engineering Publishers, Elizabeth, N. J. 165 p., $6^1/_2 \times 9^1/_2$ in., bound. $6. The basic concepts and philosophies, techniques, and applications of value engineering are contained in these papers, originally presented at the Electronics Industries Association Conference on this new engineering specialty, held at the University of Philadelphia in October, 1959. Categorizing engineering of the past as "Performance Engineering," or the development of a product to perform a service required by a recognized need, with secondary attention to costs, proponents of value engineering see it as fulfilling the demands of the present era by providing techniques which will vastly reduce costs of present products and evolve better products for known needs as well as by searching out new needs.

Accident Prevention Manual for Industrial Operations

Fourth Edition. Published 1959 by the National Safety Council, Chicago, Ill. Various pagings, 6×9 in., bound. $15. This 4th edition contains new material on ionizing radiation, nondestructive testing, foundry operations, and elevators; and all chapters have been revised. Industrial safety and accident prevention, insurance, injury rates, and employee education are general considerations; specific plants and machinery such as boilers, materials handling equipment, power trucks, chains, ropes, wood working machinery, power presses, welding equipment, and power tools are then covered. The handling of materials—flammable, chemical, electrical, poison, and radioactive—is discussed, in each case listing dangers and accident prevention measures. Personal hygiene and protection are also explained.

Advanced Engineering Mathematics

By C. R. Wylie, Jr., Second Edition. 1960, McGraw-Hill Book Company, Inc. New York, N. Y. 696 p., $6^1/_4 \times 9^1/_4$ in., bound. $9. An introduction to those branches of mathematics relevant to the engineer and the physicist, this edition contains a new chapter on determinants and matrices, and one on finite differences which includes the theory of orthogonal polynomials and the techniques of numerical analysis. Ordinary, linear, and simultaneous linear differential equations are

covered thoroughly, and the section on partial differential equations includes solution by Laplace transform. Detailed treatment also is accorded the Fourier series, Bessel functions, Legendre polynomials, vector analysis, conformal mapping, and the theory of residues.

American Society of Tool Engineers Collected Papers 1959, Book 2

Published 1959 by the ASTE, Detroit, Mich. Various pagings, 8½ × 11 in., paper. No price given. This volume continues the practice begun in 1958 of twice-yearly publication of technical papers presented at the annual and semi-annual meetings of the ASTE, coincident with the meeting dates. These papers contain the substance of the latest developments in the field of manufacturing and production-tool engineering, discussing the major factors affecting manufacturing costs in terms of analysis, evaluation, and control of these costs. The papers include monographs, charts, statistics, and illustrated accounts of practical applications.

Analysis of Deformation, Vol. 4: Waves and Vibrations

By Keith Swainger. 1959, The Macmillan Company, New York, N. Y. 370 p., 5¾ × 8¾ in., bound. $15. In this fourth volume on wave mechanics and vibration, the formulation of the theory of deformation is examined for the propagation of stress through, and on the surface of, substances possessing various physical properties such as elasticity, plasticity, fluidity, and combinations of these effects. The effect of rate-of-load application and reduction on the speed of wave propagation is studied. The classical analyses are given and examined critically, and, in some cases questioned. A unified mechanistic theory is presented of the cause of earthquake waves, volcanoes, and the crustal features of the earth.

Analysis of Statically Indeterminate Structures

By Clifford D. Williams. Fourth Edition. 1959, International Textbook Company, Scranton, Pa. 360 p., 6½ × 9 in., bound. $9.25. Efforts made since 1943 to simplify and render more understandable the methods used in structural analysis are embodied in this fourth edition of a comprehensive text designed to provide a firm grounding in the basic principles and concepts of action of structural members subject to load. Presented are common methods of analysis of statically indeterminate structures in simple form, based on the fundamental principles of applied mechanics. Examples and practical problems are included to illustrate the use of an analytical approach and induce development of problem-solving procedures.

Available Energy and the Second Law Analysis

By Edward A. Bruges. 1959, Academic Press Inc., New York, N. Y. 124 p., 5½ × 8¾ in., bound. $5.50. Introductory chapters are on the first and second laws of thermodynamics and are preparatory for the rest of the book, since both laws are considered in the following analysis of available energy in the mixing of gases, vapors, and liquids; heat-exchangers; turboblowers; air compressors; gas dynamics; refrigeration and power plants. The final chapters concern chemical changes, both theory and problems.

Cathodic Protection

By Lindsay M. Applegate. 1960, McGraw-Hill Book Company, Inc., New York, N. Y., 229 p., 6 × 9¼ in., bound. $9. This practical book on the prevention of corrosion by electrolytic means describes the making of the necessary field surveys and tests, the interpretation of test results, and the design and construction of the appropriate cathodic protection installations. Operational examples are given of the protection of such underground and submerged structures as pipelines, cables, aviation fuel tank and line systems, lock and dam gates, and ships in storage. Also included is an examination of the relationship of cathodic protection to static and power grounding systems.

Cemented Carbides

By Paul Schwarzkopf and others. 1960, The Macmillan Company, New York, N. Y. 349 p., 6¼ × 9½ in., bound. $15. The historical development of cemented carbides traced in the first chapter is followed by chapters on production and testing methods for carbides and other metallic refractories, with emphasis on sintering. The mechanical and chemical properties of commercially produced carbides and those produced only in experimental quantities, such as oxide and boride materials, form the next chapters, and the final chapters deal with applications of cemented carbides in the machine tool, mining, defense, and other industries.

Data Book for Civil Engineers, Vol. 1: Design

By Elwyn E. Seelye. Third Edition. 1960, John Wiley & Sons, Inc., New York, N. Y. Various pagings, 9¾ × 12 in., bound. $24. A concentrated, tabular, and illustrated collection of design data for civil-engineering structures, with new material in this third edition in the sections on structural steel, concrete, wood, aluminum, and masonry; wind pressures on structures; pavements, highways, airports, bridges, and waterfront structures; and in drainage and sewage systems. All sections have been revised in accordance with the latest data, codes, standards, and practice.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting March 11, 1960, and approved by the board on April 28, 1960.)

Case 1265
(*Special Ruling*)
Use of Cast Aluminum Alloy S5A

Inquiry: May aluminum casting alloy S5A meeting the requirements of ASTM Specification B 26-58T be used in unfired pressure vessels which are to be constructed and stamped in accordance with the rules of Section VIII of the ASME Boiler and Pressure Vessel Code?

Reply: It is the opinion of the Committee that aluminum casting alloy S5A of ASTM Specification B 26-58T may be used for unfired pressure vessels constructed and stamped in accordance with Section VIII under the following conditions:

(1) The following maximum allowable stress values multiplied by the casting factors specified in Par. UG-24 shall be used with the design rules when reference is made to Table UNF-23:

For Metal Temperatures Not Exceeding Deg F

100	150	200	250	300	350	400
4000	4000	3700	3400	3100	2850	2550

(2) This alloy shall not be welded.

Case 1281
(*Special Ruling*)
Attachment of Jackets to Jacketed Vessels

Inquiry: Item (5) of Table UW-12 of the 1959 Edition of Section VIII limits single full fillet lap joints with plug welds

to circumferential joints for attachment of heads not over 24 in. diameter to shells not over $1/2$ in. thick. In view of the fact that earlier Editions permitted circumferential joints of this type in shells not over $5/8$ in. thick with no restriction on diameter, may jackets be attached to vessels by means of single full fillet lap joints and plug welds.

Reply: It is the opinion of the Committee that Item (5) of Table UW-12 of the 1959 Edition of Section VIII was not intended to limit the diameter of vessels to which jackets could be attached by single full fillet lap joints with plug welds provided the following conditions are met:

(1) The plug welds meet the requirements of Par. UW-17.

(2) The distance from the center of the plug weld to the edge of the plate is not less than $1\,1/2$ times the diameter of the hole for the plug.

(3) The nominal thickness of the jacket (see Par. UA-60(h)(3)) does not exceed $5/8$ in.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1959

PAR. P-12(b)

In the first sentence delete "in Specification SA-48 for Gray Iron Castings."

PAR. P-23(c)

In the second paragraph, first sentence delete "or threaded brass or copper pipe."

PAR. P-26

Revise to read:

Maximum allowable working pressure in pounds per square inch for seamless nonferrous tubes and pipes conforming to specifications given in Section II of the Code are to be determined by the following formula, for outside diameters $1/2$ in. to 6 in., inclusive, and for wall thicknesses not less than No. 18 BWG (0.049 in.):

$$P = \frac{2St}{D} + C$$

where

P = maximum allowable working pressure, pounds per square inch
t = minimum wall thickness, inches
S = maximum allowable working stress from table P-6, pounds per square inch
D = outside diameter of tube or pipe, inches
C = allowance for threading and minimum structural stability, inches

The values of C do not include any allowance for corrosion and/or erosion, and additional thickness should be provided where they are expected. The allowances for threading and minimum structural stability are not intended to provide for conditions of misapplied external loads or for mechanical abuse.

The values of C shall not be less than those shown in Table 1.

(1) Additional wall thickness should be provided where wear due to cleaning operations is expected, and to compensate for thinning in setting the tubes in tube plates.

(2) Depth of thread shall be taken as

$$\frac{0.8}{\text{Number of threads per inch}}$$

PAR. P-103(a)

In first sentence add Spec. SA-306 to the Specifications listed.

PAR. P-262

In first sentence revise SA-48 to read SA-278

PAR. P-321

In second sentence revise SA-48 to read SA-278

Material Specifications, 1959

SA-306 Par. 5(a) add: carbon, max. per cent, 0.35.

The Boiler and Pressure Vessel Committee has approved adding to Section II the following new Specification.

SA-433-59T Spec. for Leaded Carbon Steel Plates of Flange and Firebox Qualities for Fusion Welded Boilers and Other Pressure Vessels.

Welding Qualifications, 1959

PAR. Q-23(a)

Revise to read:

Q-23 Test Joint (a) Information regarding the essential variables given in Par. Q-22 above (filler metal, welding position, process, etc.) shall be listed in the Manufacturers Record of Welder Performance Qualification Test (see Appendix II—Recommended Forms). Other details such as preheat, postheat, base materials, etc., which are essential variables of any procedure specification qualified by the manufacturer shall be followed in making the performance qualification except as otherwise allowed below. The dimensions of the test material and the length of the weld shall be sufficient to provide the required test specimens.

PAR. QN-22W-1

Add the following at end of Par.: (except as in Par. QN-24(e)).

PAR. QN-23(a)

Revise to read:

QN-23 Test Joint (a) Information regarding the essential variables given in Par. QN-22 above (filler metal, welding position, process, etc.) shall be listed in the Manufacturers Record of Welder Performance Qualification Test (see Appendix II—Recommended Forms). Other details such as preheat, postheat, base materials, etc., which are essential variables of any procedure specification qualified by the manufacturer shall be followed in making the performance qualification except as otherwise allowed below. The dimensions of the test material and the length of the weld shall be sufficient to provide the required test specimens.

PAR. QN-23(e)

Add the following new paragraph:

When a welder is to be qualified to weld on aluminum alloy materials, the test specimens for welder or operator performance qualification may be any one of the aluminum and aluminum base alloys shown in Table QN-11.1.

PAR. QN-23(f)

Add the following new paragraph:

When a welder is to be qualified to weld on nonferrous alloys other than aluminum and aluminum base alloys, the test specimens for welder or operator performance qualification shall be of material in accordance with Par. QN-22, W-1.

Table 1 Values of C

Use	Size Range	Value of C
Boiler Tubes—Rolled (1)	$1/2$–6″ OD inclusive	0
Boiler Tubes or Pipe—Threaded	Under 4″ OD	Depth of thread, but not less than 0.065 (2)
Pipe—Threaded	4–6″ OD inclusive	Depth of thread (2)
Pipe—Plain End	Under 4″ OD	0.065
Pipe—Plain End	4–6″ OD inclusive	0

Current Engineering: Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Science and Technology Are Liberal Arts, Says Dean J. R. Dunning

Dean's report tells how Columbia University Engineering School has responded to changing needs in education

Too MANY leaders of modern society are ignorant of the science and technology that are revolutionizing human life in this century, Dean John Ray Dunning, Mem. ASME, of the Columbia University School of Engineering, asserts in a recent report.

A pioneer atomic scientist and frequent adviser to the Federal Government on problems of research and defense, Dr. Dunning states that many of even our most sophisticated statesmen and educators are committed to what he calls "myopic humanism."

Too many, he adds, regard art and philosophy as the highest accomplishments of human life, and ignore man's astonishing achievements in science and technology.

In our statesmen and educators it leads to a particularly dangerous kind o ignorance, because we are living through a great technological revolution, the report says, "an age during which a radically new form of society may be emerging, based on an explosion of science and technology that could completely alter the environment to which man, in a million years of painful evolution, has adapted his physical and mental make-up."

Dean Dunning's report, entitled "Science, Engineering, and the Liberal Arts," lists four engineering facts of life which control the work of a modern engineering school, but also must be faced by all educated men, he says. They are products of the technological revolution of our times, and they are bringing about the rapid and possibly total industrialization of human society.

Facts of Life—Engineering. The engineering facts of life are these:

1 That within our own lifetimes we will have exhausted our resources of coal and oil and will have to turn to nuclear and thermonuclear energy sources.

2 That man, because of automation, may no longer have to earn his bread "in the sweat of his face."

3 That because of the development of modern weapons, no one can really count on living more than another half hour.

4 That human beings may be visiting neighboring planets within decades, and may go beyond the borders of this solar system by the end of the century.

In the light of these facts "it is surely a provincialism of the intellect," the report continues, "to hold that a man who knows history, literature, and foreign languages but not mathematics, physics, and biology, is an educated man."

What Columbia Did. How the Columbia Engineering School has responded to these facts of technological life by expanding its graduate curriculum, and by establishing a new four-year collegiate division, offering "a liberal education in science and engineering. . .," is described in the report.

This four-year division, whose first 100 freshmen entered the School in September, 1959, supplements Columbia's existing undergraduate engineering program. In this program, college students take two years of professional engineering work after they have completed two, or more usually, three years in a liberal arts college.

Dean Dunning says the philosophy underlying the new four-year course is one that envisions sharp distinctions between "science" and "the liberal arts" as obsolete.

Science and Technology Are Liberal Arts. The report continues by asserting that science and technology are liberal arts, and that "liberal education has always been concerned with establishing man's position in the universe, and now that modern man has achieved an unprecedented degree of control over his physical destiny, our ideas of that position are changing. If education is to remain 'liberal' in any real sense, educators must admit that these ideas have resulted from the growth of science and technology, they must recognize that rapid further change is inevitable, and they must incorporate into their programs those disciplines that have produced and will continue to produce such changes. The conviction that science and technology are liberal arts leads to the conclusion, the report points out, that concentrated study of them on the college and professional levels can constitute the core of a liberal education just as can the study of literature, philosophy, political science, or social science."

Professional Practice. Recent rapid advances in science and technology have changed the professional practice of engineering from the routine use of traditional knowledge to a highly experimental activity in which the engineer creatively discovers and develops the natural science and mathematics he needs for a specific job. "Engineering research operates at the intersection of pure with applied science," the report continues, "and no man can tell with certainty precisely where that intersection is."

Large-scale research projects, like those sponsored by industry and the federal government, have become a vital part of the efforts of engineering schools to extend the frontiers of the scientific knowledge on which modern technology depends. Some observers still fear that

such projects may divert universities from true scholarly work into the "production of military hardware," Dean Dunning notes, while others fear that research budgets from industry and government may make universities susceptible to outside control.

These fears have diminished in the past few years, according to Dean Dunning, because the policies under which federal government and private industry have sponsored research have continually improved, and further improvement is possible and expected.

Meanwhile, a properly conceived and soundly administered university policy on sponsored research—such a policy as Columbia now adheres to—can make certain that the university remains master in its own house while keeping abreast of the newest developments in science and technology off the campus. Dr. Dunning argues that the objections raised by academic scholars that government research projects, because they are "practical" rather than theoretical, are not truly intellectually productive, is groundless.

"The history of science," he says, "shows that the solution of specific problems has stimulated at least as much fundamental discovery as pure intellectual curiosity has." Such research "vastly multiplies basic engineering and scientific knowledge, and therefore constitutes one of the most truly creative activities in the university," he continues.

Objective Verification. In fact, Dr. Dunning asserts, much of the research conducted by university departments in the traditional humanities is less creative than that in pure and applied science. Research in history, philosophy, and philology, for instance, he says, is "primarily a critical activity, offering relatively little opportunity for the play of creative imagination, and having relatively little apparent effect on human life." On the other hand, the dean says, the scientific and engineering research scholar "is engaged in creating new forms of knowledge that must meet the severest test within the power of the human intellect: objective verification."

This activity produces a "provisional form of knowledge that has profound effects on the circumstances of human life and on the content of human belief in philosophy, art, and religion. This is scientific research," says Dean Dunning, "and this in all its forms is a supremely creative activity."

Start Young. Columbia's School of Engineering, Dean Dunning also reports, has experimented with revision and enrichment of high-school preparation for science and engineering by means of its Joint Program for Technical Education, with the support of the Hebrew Technical Institute of New York, the New York Foundation, the Ford Foundation, and the National Science Foundation. In an effort to determine just how much science and technology bright high-school students can absorb, it has given college-level courses on Saturdays during the school year, and in Summer Institutes, in subjects ranging from thermodynamics to physics and electricity, and from astronomy to anthropology. The enthusiasm and achievement of the high-school students, selected from schools in the metropolitan area by competitive examinations at Columbia, has amply confirmed, says the report, the belief that the intellectual capacities of high-school students can be much more deeply challenged than is usually the case in modern secondary school work.

EDUCATION

New Curriculums

● New York University School of Education will offer, beginning next fall, what is believed to be the first four-year undergraduate curriculum in prosthetics and orthotics—the design, fabrication, and fitting of artificial limbs and braces. The program, developed in conjunction with the university's Post-Graduate Medical School and College of Engineering, is intended primarily for persons interested in the clinical practice of prosthetics and orthotics.

● Western Reserve University School of Library Science, Cleveland, Ohio, is offering a program in the new field of documentation, that aspect of librarianship concerned with improving graphic communication within and among groups of specialists. The program for documentation specialists offers specialized courses in this new field in library science which, together with basic professional courses, leads to the degree of Master of Science in Library Science.

● Wayne State University, Detroit, Mich., is expanding its graduate program of the Engineering Mechanics Department to include the doctoral level. Graduate students who complete the course and dissertation requirements will become eligible for the degree of Doctor of Philosophy in Engineering Mechanics.

Summer Courses

● **Pennsylvania State University,** University Park, Pa.: Research and development-management development seminar, July 24–29. Work measurement seminar, August 28–Sept. 2. Technical report writing seminar, Sept. 19–30.

● **University of Michigan,** Ann Arbor, Mich.: Applied mathematics for chemical and metallurgical engineers, July 11–20.

Signal detection and psychophysics, July 11–22. Semiconductor theory and technology, fundamentals, July 11–16; advanced, July 18–23; or both, July 11–23.

Solid-state microwave amplifiers and oscillators, fundamentals, July 18–22; advanced, July 25–29; or both, July 18–29.

Freehand pictorial engineering design sketching, August 1–12. Quality control by statistical methods, August 15–25.

● **University of California,** Los Angeles, Calif.: Industrial photoelasticity, lectures and laboratory, August 15–19. Strain-gage techniques, lecture course, August 22–26. Strain-gage techniques, laboratory program, August 29–Sept. 2.

● **Colorado State University,** Fort Collins, Colo.: Institute in technical and industrial communications, July 11–15.

● **Massachusetts Institute of Technology,** Cambridge, Mass.: Industrial photoelasticity, June 27–July 1. Modern developments in heat transfer, June 27–July 8.

Prof. John Warner, **left,** Tufts College, Medford, Mass., and Prof. John Truxal, **center,** Dean of Engineering, Polytechnic Institute of Brooklyn watch Henry Blackstone, president of Servo Corporation of America, demonstrate how Servolab servo-system simulator is used to train students in control-systems engineering. Professor Truxal was one of a panel of speakers at an engineering education symposium at the Savoy-Hilton Hotel, New York City, Feb. 19. He predicted the breakdown of classical electrical engineering boundaries into two areas—electrophysics and electromechanics.

LITERATURE

ASME Publications

The following publications are available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.:

"Latest Technology in Oil and Gas Power." The proceedings of the 31st annual Oil and Gas Power Conference held April 20–23, 1959, at the Shamrock-Hilton Hotel, Houston, Texas, sponsored by the Oil and Gas Power Division of ASME with co-operation of the Houston section, obtainable for $3 a copy.

Addenda. The following addenda to the ASME Boiler and Pressure vessel Code are available:

Welding Qualifications, 1959 edition: Winter 1959 Addenda issued Jan. 15, 1990; and 1960 Addenda issued Jan. 5, 1960.

Unfired Pressure Vessels, 1959 edition: Winter 1959 Addenda issued Jan. 20, 1960.

Low-Pressure Heating Boilers, 1959 edition: 1960 Addenda issued May 10, 1960.

Miniature Boilers, 1959 edition: 1960 Addenda issued May 10, 1960.

Power Boilers, 1959 edition: 1960 Addenda issued May 10, 1960.

Material Specifications: 1960 Addenda issued April 15, 1960.

Interpretations. "Code for Pressure Piping Interpretations," corrected to March 1, 1960, has been published.

"Interpretations of the Code for Pressure Piping, Case No 45," was reprinted from Mechanical Engineering, March, 1960.

Standards

- "Spindle Noses," ASA B5.9–1960, $2.50.
- "Cast-Bronze Solder-Joint," ASA B16.23–1960, $2.
- "Machine Tapers," ASA B5.10–1960, $2.50.
- "Large Rivets," ASA B18.4–1960, $1.50.
- "Letter Symbols for Rocket Propulsion," ASA Y10.14–1959, $2.
- "Wrought-Steel and Wrought-Iron Pipe," ASA B36.10–1959, $1.50.

Copies available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

ECPD

The 27th Annual Report—1958–1959 of the Engineers' Council for Professional Development is available for $1 a copy from ECPD, 29 West 39th Street, New York 18, N. Y.

ESL

ESL Bibliography No 14, a Bibliography on Filing, Classification, and Indexing Systems for Engineering Offices and Libraries, is available at $2 a copy from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

New Journals

- "Technology and Culture," The International Quarterly of the Society for the History of Technology, is the new official publication of the society. Edited by Melvin Kranzberg, professor of history at Case Institute of Technology where the society has its headquarters, it is published by Wayne State University Press. Price to nonmembers is $7 a year, $12.50 for two years, $18 for three years; add 15 cents a year in Canada, 35 cents a year abroad. Single copies, $2. Available from: The Society for the History of Technology, Room 311, Main Building, Case Institute of Technology, Cleveland 6, Ohio.
- The first issue of the second volume of "The Journal of Mechanical Engineering Science" has been published by The Institution of Mechanical Engineers. The new journal will appear in March, June, September, and December. Annual subscription rates will be £1 10s. 0d. to members and £3 0s. 0d. to nonmembers. Single copies are 10s. 0d. to members and £1 0s. 0d. to nonmembers. Available from the Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, England.

COMING MEETINGS

Materials Science

The 63rd annual meeting of the American Society for Testing Materials to be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., June 26-July 1, 1960, will be highlighted by an appraisal of the present state of knowledge of several facets of materials science. The ASTM Division of Materials Sciences has organized an all-day, two-symposiums program for June 27 on recent progress in materials sciences and on the nature and origin of strength of materials.

In other sessions, attention will be given to solar energy, nuclear fuel element development, low-temperature properties of high-strength aircraft and missile materials, acoustical fatigue, and radiation effects and radiation dosimetry as well as several other topics.

Dr. R. Carson Dalzell, Mem. ASME, assistant to director, Division of Reactor Development, U. S. Atomic Energy Commission, is to be Gillett Memorial Lecturer. His subject will be "Nuclear Fuel Elements Development." The annual Edgar Marburg Lecture will be presented by Dr. Farrington Daniels, vice-president of the National Academy of Sciences and professor-emeritus of the University of Wisconsin, whose topic will be "The Utilization of Solar Energy."

An informal panel discussion on low-cycle fatigue, sponsored by the Applied Research Panel of the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals, will be held at 3:00 p.m., Wednesday.

The ASTM biennial exhibit of testing apparatus and laboratory supplies will be held throughout the five-day week, opening Monday noon and closing Friday noon. Exhibitors will display their new developments in testing and scientific apparatus.

Human Engineering

The eighth annual Human Engineering Conference, sponsored by the Office of Naval Research, will be held at the Defence Research Medical Laboratories, Toronto, Canada, July 12–13. Scientists and engineers of Canada and the United States who are working with problems involving the human element in the design of man-machine systems will participate in panel discussions to improve communications and research co-ordination. Canadian Defence Research Board is host for the conference.

MEETINGS OF OTHER SOCIETIES

● IN MEXICO

June 19–22

AIChE, joint meeting with IMIQ, Del Prado Hotel, Mexico City, Mexico.

● IN THE UNITED STATES

June 20–24

ASCE, Reno Convention, Reno, Nev.

June 20–24

ASEE, annual meeting, Purdue University, Lafayette, Ind.

June 20–24

AIEE, summer general meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

June 26–July 1

ASTM, annual meeting and exhibit, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

June 27–29

IRE, national conference on military electronics, Sheraton-Park Hotel, Washington, D. C.

June 27–30

National Association of Power Engineers, annual convention, Jack Tar Hotel, San Francisco, Calif.

June 28–July 1

IAS, national summer meeting, Ambassador Hotel, Los Angeles, Calif.

July 11–12

TMS, Conference: Response of materials to high velocity deformation, sponsored by the Physical Metallurgy Comm., Inst. of Metals Division, Stanley Hotel, Estes Park, Colo.

● IN EUROPE

June 15–29

National Committee for Nuclear Research, seventh international nuclear congress and exhibition on electronics and atomic energy, Rome, Italy.

June 25–July 5

International Federation of Automatic Control, first congress, Moscow, Russia.

June 27–July 1

International Association for Bridge and Structural Engineering, sixth congress, Stockholm, Sweden.

June 27–July 1

International Organization for Standardization, council, Geneva, Switzerland.

Aug. 22–27

Koninklijk Instituut van Ingenieurs, seventh conference on coastal engineering, The Hague, Holland.

Aug. 28–31

Verein Deutscher Ingenieure-Hauptgruppe History of Technology in co-operation with the Deutsche Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik (Bonn), Lüneburg, Germany.

Aug. 29–Sept. 3

Société Royale Belge des Ingenieurs et des Industriels, host to EUSEC Conference, Brussels, Belgium.

Sept. 16–20

Société Hydrotechnique de France, symposium on "Hydraulic Turbine Research," Nice, France.

Sept. 21–23

VDI, Commission for Clean Air, Questions on Clean Air, Wiesbaden, West Germany.

Oct. 2–5

VDI, Society for Chemical Engineering in the Association of German Engineers, Mannheim, Germany.

Mid-October

VDI-Fachgruppe Vibration Engineering, vibration conference, Essen, Germany.

Oct. 17–19

K.I.v.I., International Congress on Plastics, Amsterdam, Holland.

Oct. 20–21

VDI-AWF-Fachgruppe Gear Engineering, International Conference on Gearing, Essen, Germany

● IN JAPAN

July 11–18

Science Council of Japan, Second World Conference on Earthquake Engineering, Sankei Kaikan, Tokyo, and Kokusai Bunka Kanko, Kaikan, Kyoto, Japan.

(*For ASME Coming Events see page 122.*)

INDUSTRIAL FILMS

Conveyer System

THE world's longest permanent transport belt conveyer system, $5\frac{1}{2}$ miles in length, is the subject of Link-Belt Company's new 16-mm, sound and color, 22-min motion picture, "Ideal Transport Story." The film shows all phases of construction of the unique system from survey and site clearance through operation. The all-weather conveyer is the first major installation supported by prestressed concrete structures and is made up of seven separate belt conveyers, arranged to feed onto each other consecutively. One conveyer, almost $2\frac{1}{4}$ miles in length, requiring a belt $4\frac{1}{2}$ miles long, is the longest single flight ever built. The conveyer winds through Oklahoma carrying limestone and shale at the rate of 1000 tons an hour from Ideal Cement Company's quarry in Lawrence to its plant in Ada.

The film may be borrowed for showing in the U. S. A. without cost on letterhead request. Available from: Link-Belt Company, Dept. PR, Prudential Plaza, Chicago 1, Ill.

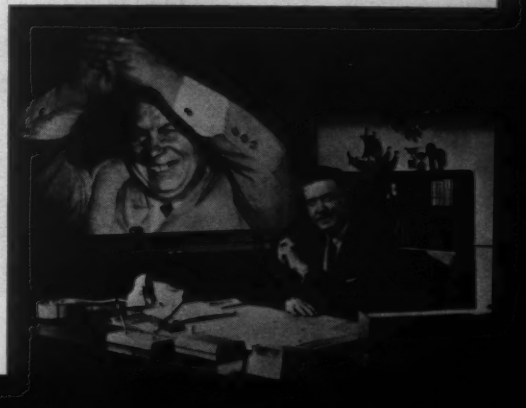
Specialty Steels

A NEW 45-min color film, "Specialty Steels," telling the story of the science and the art which go into producing the special-purpose steels such as stainless steels and tough-wear, shock-resistant steels for the tool room, has been made for the Crucible Steel Company of America. Produced by Marshall Organization, Inc., New York, N. Y., it was photographed at Crucible's large integrated mill at Midland, Pa., and at Sanderson-Halcomb Works, Syracuse, N. Y. Available from: Crucible Steel Company of America, Dept. TA-4, P. O. Box 2518, Pittsburgh 30, Pa.

"The Master Builders," a 16-mm, 28-min, color film, has been produced by F. H. McGraw & Company, New York, N. Y., in collaboration with plant owners Olin Mathieson and Ormet Corporation. Covering the construction of a large industrial complex—the $231-million Ormet-OM aluminum facility—the documentary-type film should prove interesting to engineering schools, technical meetings, and the like. Available from: F. H. McGraw & Company, 51 East 42nd Street, New York, N. Y. Cameraman H. Coleman, in foreground, is shown on location making the film.

Photomicrography (Publication)

A NEW "how-to" booklet, "Photomicrography of Metals," has been published by Eastman Kodak Company. Written in layman's language, the booklet contains detailed information on the metallographic microscope, illumination, filters in metallography, photographic materials, exposure determination, processing, and printing. The 46-page, illustrated data book may serve as a short course for those interested in reviewing the latest techniques in this field and as a supplemental text for college-level metallurgy students. Available through Kodak dealers, for 50 cents; or directly from Sales Service Division, Eastman Kodak Company, Rochester 4, N. Y., for 50 cents plus 10 cents handling charge.



The image of Soviet Premier Nikita Khrushchev appears in the background as Arthur Gilmore narrates in a scene from "A Letter to Moscow." This 16-mm, 28-min color film portraying the strength of the American economic system of free enterprise is being distributed nationally by the Armstrong Cork Company. It traces the growth of a typical American company to show how it was able to develop and prosper in our free society and illustrates how the nation's competitive enterprise system contributed to America's high standard of living. Available without charge from: Armstrong Cork Company, Lancaster, Pa., or any of its district offices.

United Engineering Center

Going Up: UEC Structural Steel

THE first steel beams in the United Engineering Center swung into place on April 29, several days ahead of schedule. Placing of the beam on the southeast corner of the building site marked another step in the rapid construction progress on the new building.

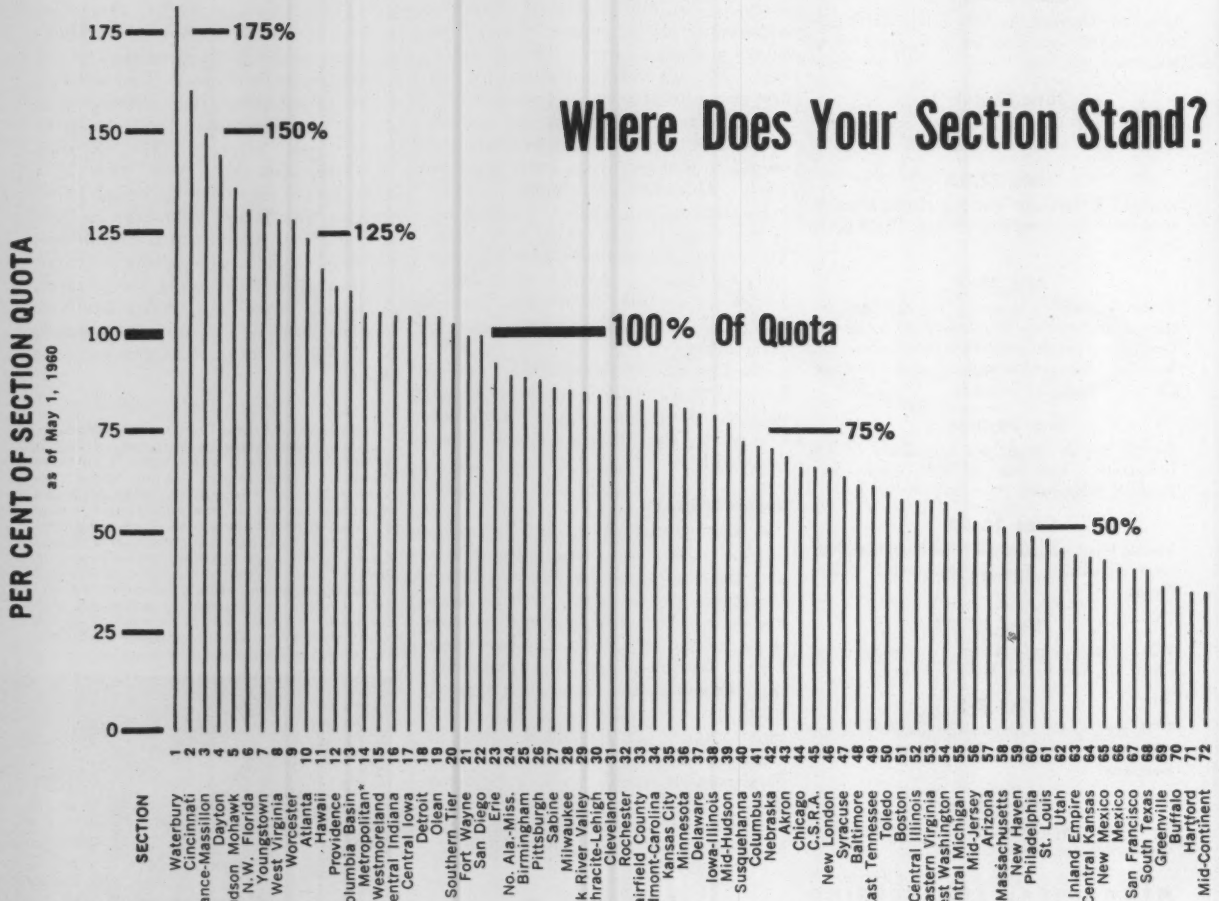
Matching steel supports now dot the section of the lot at United Nations Plaza and 47th Street. They will be part of the underpinning for the lobby and main entrance of the 20-story structure. In all, 3300 tons of steel will be used in the frame of the building. When finished, the Center will rise 283 ft above ground level.

Meanwhile, the Detroit Testing Laboratory submitted its report on tests conducted on a curtain-wall mockup of the building's exterior. Resistance to air, water, and wind infiltration were investigated on a reconstruction of two full window bays (with spandrels above and below). The tests showed satisfactory results in every respect, according to the laboratory report.

At ASME some gains also were registered in the Member Gifts Campaign as San Diego topped 100 per cent, becoming the 22nd Section to reach the full quota mark. This leaves 71 Sections short of their quotas.

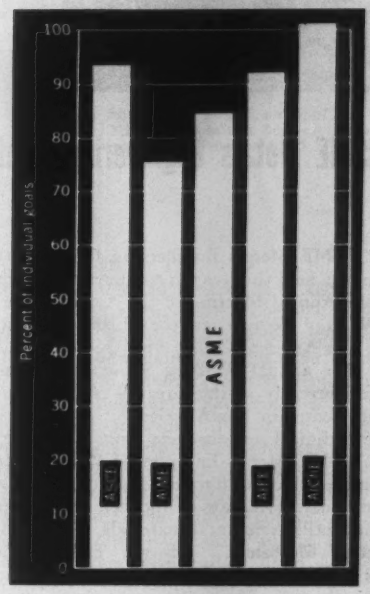
The Toledo Section registered the biggest gain, moving from 46.3 per cent of quota to 60 per cent. Reports from other Sections were less encouraging, resulting in a gain for the month of only one per cent to a total of 84.5 per cent of quota.

Where Does Your Section Stand?



The first steel column in what will be the 20-story United Engineering Center is shown being put in place at United Nations Plaza and 47th Street, New York City. Thirty-three hundred tons of steel will comprise the all-welded frame. Being financed by voluntary contributions from industrial concerns and individual engineers, the UEC will house 18 major engineering societies representing 300,000 individuals. General contractor is Turner Construction Company. Dreier Structural Steel Company, Inc., of Long Island City, N. Y., is fabricating and erecting the steel framework. Architects are Shreve Lamb & Harmon. Seelye, Stevenson, Value and Knecht are structural engineers.

How Is ASME Doing?



United Engineering Center Member Gifts Campaign status as of May 1, 1960

Here, a construction worker scales first steel beam after crane has swung it into position. Part of concrete UEC basement wall can be seen on left.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Metals Engineering Conference Held in Conjunction With AWS Annual Meeting

More than 900 attend meeting in Los Angeles

THE ASME Metals Engineering Conference was held this year in conjunction with the Annual Meeting of the American Welding Society at the Biltmore Hotel, Los Angeles, Calif., April 26–28, 1960. The annual Welding Show was held concurrently at the Great Western Exhibit Center in Los Angeles.

Four technical sessions were sponsored by the ASME Metals Engineering Division on the subject of fracture mechanics, welding and fabrication of Inconel, and on nonmetallic structural materials.

Fracture Mechanics. Of the eight papers on fracture mechanics, four were on basic theory. The macroscopic characteristics of fatigue-crack propagation were studied experimentally and analytically [11].[1] Crack initiation was separated from propagation and ignored in order to achieve a better understanding of the fundamentals of fatigue fracture. Dimensional analysis was used for crack propagation in the semi-infinite sheet under constant stress range and mean stress. An expression for crack length in terms of number of cycles of load and a stress-dependent propagation factor was obtained.

Crack propagation was divided into initial, middle, and final periods, and it was found that propagation was slow and sporadic in the initial period. Machining irregularities, microscopic inhomogeneities, and difficulties in measurement (length was less than 0.07 in.) were considered factors in this. In the middle period (about 40 to 50 per cent of propagation life) measurements agreed with the predictions from equations.

In the final period, crack propagation was greatly accelerated because of an increase in stress range and mean stress as the net section was reduced and a disproportionate increase in the size of the plastic zone which changed the stress distribution and the mechanism of fracture. When the expression for a semi-infinite sheet was modified for crack propagation in a specimen of finite width, accurate prediction of the propagation life became possible.

In another study of fatigue failure [1] it was concluded that fluctuating strain energy could not be the prime cause since fatigue cracks were produced in regions where the strain energy was essentially constant during the test. Conversely, it was inferred that fatigue failure must result from fluctuation of some component of stress or strain referred to particular planes of the material, such as a critical shear stress.

While strain-energy forms of expressions may be useful as design formulas for combined stress, they are not valid for describing the mechanism of fatigue and may result in incorrect results when used for describing fatigue under states of combined stress outside the experimentally verified range.

The importance of measuring strain as well as stress in research on fatigue fracture, ignored for some time, was reemphasized by a study of microplastic-strain hysteresis energy as a criterion for fatigue fracture [2]. Studies in low-cycle fatigue (less than 10,000 cycles) have indicated that the cyclic plastic-strain range or the width of the hysteresis loop is a much more satisfactory quantity to correlate with fatigue life than stress.

Longer life was predicted for SAE 4340 steel, by an analysis than actually measured, because of the hysteresis loop in the high fatigue-stress region. The slight decay of hysteresis energy for stresses at or below the fatigue limit demonstrates that damaging plastic-strain hysteresis energy dies out due to cyclic strain-hardening before the accumulation of the critical total plastic energy to cause fracture. The analysis can be corrected for these factors and additional investigations of the validity of microplastic-strain hysteresis energy as a criterion for fatigue failure are needed with a variety of materials.

The authors determined in a study of theories of fracture of brittle materials such as high-silicon cast iron [4], that essentially the stress systems involved may be related to, or formulated in terms of, an average shearing stress acting on an infinitesimal volume in the body of the solid. The effect of structural factors may be summed in terms of a notch-concentration factor K, based on hypothetical and fictitious cavities within and at the surface of the material. Equations may then be obtained which conform to the data available as far as engineering purposes are involved and considering the statistical limitations of the data.

In the papers on specific applications of fracture mechanics, the effect of J-stiffeners—parallel to a simulated crack—on crack propagation in relatively large 0.40-in-thick 2024-Ts clad aluminum sheets was tested for both curved and flat sheets and compared with similar tests on unstiffened sheets [3].

The location of the 0.008-in. saw-cut crack varied among: (*a*) Halfway between stiffeners, (*b*) in the rivet row of the centrally located stiffener, and (*c*) immediately adjacent to the center stiffener.

Materials for a solid rocket chamber were evaluated [8] by means of the center-notch test proposed by Irwin and Kies and an order of merit was established

[1] Numbers in brackets designate papers in the availability list at the end of the report.

ASME Metals Engineering Conference was held in conjunction with AWS annual meeting in Los Angeles. View shows opening session held on April 26 at the Biltmore Hotel

B. E. Rossi, Mem. ASME, editor of THE WELDING JOURNAL, receives Samuel Wylie Miller Award from AWS President C. I. MacGuffie

for alloy steels, based on the equivalence of net section stress and yield strength. The effects of processing, treating, and fabrication techniques were also determined.

Brittle-fracture characteristics of type ASTM A302B steel used for nuclear-reactor vessels were studied [9].

Welding and Fabrication of Inconel. An entire session dealt with the welding and fabrication of Inconel for nuclear-reactor systems where it is being used for its superior corrosion resistance. A review of forging techniques and the resulting mechanical properties [5] indicated that Inconel can be forged into a variety of intricate shapes and sizes with conventional forging equipment, although it is more difficult to forge than alloy steels because of the higher elevated-temperature strength. Fuels must have low sulfur content and temperature must be accurately controlled. Ultimate strengths as high as 90,000 psi and yield strengths as high as 45,000 psi can be consistently and uniformly produced in heavy forged sections.

Arc-welding techniques were investigated for use in fabricating the alloy and for overlaying carbon steel with Inconel-type filler metals [6]. Commercially available filler metals were used and the shielded-metal-arc, inert-gas tungsten-arc, and inert-gas metal-arc welding processes were experimentally compared.

The fabrication of a 1-in-thick 10-in-diam welded Inconel pipe was described [7]. This was the company's first application of the hot-forming process to the fabrication of Inconel piping which had to meet 80,000-psi min-tensile and 30,000-psi min-yield-strength requirements.

Nonmetallic Structural Materials. The fabrication and engineering potential of Pyroceram were described [10]. The high-temperature resistance, chemical resistance, lightness and hardness, heat and electrical-insulating properties of this wholly new type of material destine it for a wide range of engineering uses. Bearings can be designed for operation at high temperatures without lubrication or in corrosive liquids. Lightweight, dimensionally stable honeycomb structures would be suitable for use in heat regenerators for gas turbines operating at high temperatures. Precision gages and machine-tool parts whose dimensions do not change with temperature are another of many potential applications. The paper will appear in a forthcoming issue of MECHANICAL ENGINEERING.

SAP, sintered aluminum powder, is another material classed with the nonmetallics because a large amount of oxide and metal are combined in the same structure [12]. The oxide film on the flake powders had a thickness of about 100 Å, and was postulated to be pierced or ruptured during a hot-extrusion process used to give a completely dense structure. The lack of solubility of oxygen or alumina in aluminum then provides an inert, stable structure. This method of dispersion-strengthened alloying can be used to improve creep strength as well as room-temperature strength of relatively low-melting-point alloys (copper, for example, gains 400 to 600 F in operating temperature with only a 20 to 40 per cent drop in conductivity).

An availability list of papers presented at the meeting follows. Digests of all papers which are not scheduled for publication in MECHANICAL ENGINEERING will appear in the "ASME Technical Digest" in this or a forthcoming issue of MECHANICAL ENGINEERING.

Availability List—ASME-AWS Metals Engineering Conference

THE papers in this list are available in separate copy form until Feb. 1, 1961. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

60—Met-1 Energy Versus Stress Theories for Combined Stress—A Fatigue Experiment Using a Rotating Disk, by W. N. Findley, E. Szczepanski, P. N. Mathur, and A. O. Temel

60—Met-2 Micro-Plastic Strain Hysteresis Energy as a Criterion for Fatigue Features, by C. E. Feltner and JoDean Morrow

60—Met-3 Fracture of Flat and Curved Aluminum Sheets With Stiffeners Parallel to the Crack, by J. Frisch

60—Met-4 A Study of Theories of Fracture Under Combined Stresses, by I. Cornet and R. C. Grassi

60—Met-5 Nickel-Chromium-Iron Alloy (Inconel) Forgings for Nuclear-Reactor Systems . . . A Summary of Forging Techniques and Mechanical Properties, by C. L. Dotson and R. L. Roshong

60—Met-6 Arc Welding of a Ni-Cr-Fe (Inconel) Alloy for Nuclear Power Plants, by Jay Bland and W. A. Owczarski

60—Met-7 Fabrication of a One-Inch Thick, Ten-Inch Diameter Welded Inconel Pipe, by W. L. Fleischmann and R. F. Gurnea

60—Met-8 The Use of the Center Notch-Tensile Test to Evaluate Rocket-Chamber Materials, by J. J. Warga

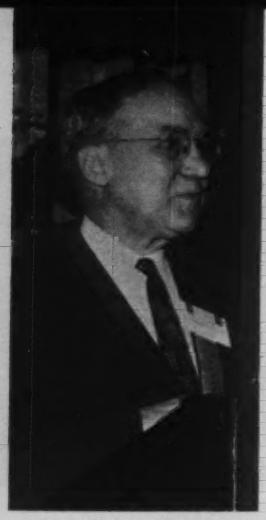
60—Met-9 Brittle Fracture Characteristics of Reactor Pressure Vessel Steel, by E. T. Wessel and W. H. Pryle

60—Met-10 Glass-Ceramics—Principles, Practice, and Properties, by S. D. Stookey

60—Met-11 Crack Propagation in Thin Metal Sheet Under Repeated Loading, by H. W. Liu

60—Met-12 Recent Advances in Dispersion Strenghtened Metal-Metal Oxide Structures, by K. M. Zwilsky and N. J. Grant

Rails, Engine Room, and Future in Research Discussed at ASME-AIEE Railroad Conference



J. W. Barriger, ASME Luncheon Speaker

E. W. Jacobson, **left**, and E. W. Allardt

P. E. Olson

E. T. Skantar

Partial view of ASME-AIEE Joint Railroad Conference Audience

THE ANNUAL conference of the Railroad Division of The American Society of Mechanical Engineers was held April 20–21, 1960, at the Penn Sheraton Hotel in Pittsburgh, Pa., with 282 in attendance. For the second time, the conference was conducted jointly with the American Institute of Electrical Engineers—and this time with the co-operation of the Pittsburgh sections of each society. In addition to the technical program, which encompassed four sessions at which 12 papers were presented, there were two luncheons at which the speakers were executives of the Pittsburgh & Lake Erie Railroad and Westinghouse Electric Corporation.

Technical Papers

Of the six ASME-contributed papers, five might be said to have been right down where the wheels meet the rails. J. C. Aydelott, of General Electric, opened the first session with a paper on the "slippery-spot concept" of adhesion. Speed-recorder tapes showing slips, both self-correcting and automatically corrected, were correlated with adhesion measurements taken by hand. The concept that low adhesion occurs intermittently was developed, and it was shown that there are stretches of good adhesion interspersed between the slippery spots. Mr. Aydelott described good slip-detection and correction means, which enable a locomotive to make use of prevailing stretches of good adhesion and effectively develop high horsepower per driving axle.

J. M. Wandrisco and F. J. Dewez, Jr., of U. S. Steel Corporation, followed with a study of defects that develop in the treads of railroad wheels. Such defects were classified in wheels that developed defects during service, and in wheels that were subjected to simulated service tests on a wheel-testing dynamometer. At least two general types of defects were found to develop during service—those caused by stresses in braking, and those caused by rolling loads. Both types were analyzed in full detail.

Another paper, by G. M. Cabble, Jr., of Westinghouse, defined the terms of wheel-rail adhesion and gave an extensive review of the adhesion problem. The author presented his own experiments made on scale equipment, showing that true adhesion varies with velocity. Suggestions were given for means of approaching true adhesion values. An added point: The danger of wheel damage caused by high adhesion could offset the advantages.

In the second technical session, Per Erik Olson and Stig Johnsson, of the Swedish State Railroads, Stockholm, Sweden, presented their paper on lateral forces between wheels and rails, dealing with a new method of measuring continuously the lateral forces over long distances. Fundamental knowledge had been obtained both from studies of short test runs and from statistical assessments of results from long sections of the Swedish railway network.

On the second day of the conference, P. W. Brath and E. T. Skantar, of Westinghouse, presented their paper on brake-control valves, reporting on the test program for railway freight brake-control valves. The paper described the design and construction of a prototype automated test machine which would allow the use of unskilled personnel as operators, and reduce total testing costs.

The one ASME paper which got up into the engine room was that of J. C. Smith of General Electric, who reported on analysis of engine lubricating oils, the spectrographic determination of wear products in used oil to determine engine wear without costly inspection of parts. Eight promising techniques have been evaluated, and the method that proved most successful was described. Among the criteria: Training time for an operator must be less than one day, and total elapsed time—including sample preparation—must be less than 30 min per sample.

Diesel to All-Electric?

Will the diesel-electric locomotive give way to the all-electric unit on the primary main lines of our railroads? At the ASME Luncheon, J. W. Barriger, president of the Pittsburgh & Lake Erie Railroad, stated his reasons for believing the electrified railroad must take over.

R. L. Wilson, chairman of the ASME's Railroad Division, served as toastmaster and introduced Mr. Barriger. The railway president, who himself has been a staunch advocate of the diesel, documented his thesis that all-electric motive power is essential to the future growth of the roads.

"On heavy-density mileage," he said, "there comes a point where the difference between the unit cost of diesel-generated current and central-station current will finance the provision of an overhead power system and leave a profit margin as a balance while affording the other

benefits of complete electrification as a bonus . . . It follows that wherever railroads have high density over long main lines, the comparative economies of central-station power for locomotive operation should be explored."

Irrespective of what type of motive power is used, obviously not all of the locomotives are working at any one time, and not all of those which are running are at full-rated capacity. Mr. Barriger estimated that about 750,000 hp of generating capacity could supply the power requirements of 3,000,000 hp of all-electric locomotive capacity, when operating at traffic levels equal to those of World War II. In short, if power were supplied from central stations instead of on the locomotives, a lot less generating capacity would be required. The actual electric-power utilization of the generating capacity of the fleet of 40,000,000 hp of diesel locomotives now in service probably does not exceed 18 per cent of rated continuous potential output.

"At 6000 hp," Mr. Barriger said, "The steam locomotive became too long, too heavy, and too cumbersome to be a serious rival for the diesel of equivalent capacity. The latter can be built up to five and six units before it suffers from similar defects, but there is a practical limit to this process at which all-electric locomotives must take over when still more horsepower can be advantageously used."

Mr. Barriger added that a great collateral advantage of railway electrification will be the return of coal as the principal source of energy for rail operation. This will have national benefits for the conservation of the nation's petroleum resources, and restore commercial relationships that were nullified by dieselization.

He said: "This, the greatest of all railway improvements, will represent the outstanding achievement of a new transportation era, and become the basic physical factor in the railroads' success as public servants and as progressive businesses."

At a later luncheon, for the AIEE, the toastmaster was P. G. Lessmann, chairman of the AIEE's Land Transportation Committee, and in the absence of S. W. Herwald, speaker, D. J. Povejsil, also of Westinghouse, delivered the paper on future trends in electrical research.

Dr. Herwald's paper summarized some of the outstanding developments which he believes will come into use in the electrical industry in the foreseeable future. He concluded, "Our systems-oriented research of the next decade should mean a great deal to all of us as individuals and as members of an advanced society."

Availability List—ASME-AIEE Railroad Conference

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60—RR-1 Study of the Defects That Originate and Develop in the Treads of Railroad Wheels During Service, by J. M. Wandrisco and F. J. Dewez, Jr.

60—RR-2 The Slippery-Spot Concept of Adhesion, by J. C. Aydelott

60—RR-3 Understanding Wheel-Rail Adhesion, by G. M. Cabble, Jr.

60—RR-4 Automated Testing of Railway Freight Brake-Control Valves, by P. W. Brath and E. T. Skantar

60—RR-5 Spectrographic Analysis of Diesel Engine Lubricating Oils by the Rotating Platform Method, by J. C. Smith

60—RR-6 Lateral Forces Between Wheels and Rails: An Experimental Investigation, by Per Erik Olson and Stig Johnsson

ASME, AIEE, and IRE Hold Automatic Techniques Conference in Cleveland

THE Third Annual Joint Automatic Techniques Conference took place April 18–19, 1960, at the Sheraton-Cleveland Hotel in Cleveland, Ohio. The Conference, sponsored jointly by The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Institute of Radio Engineers, heard and discussed 12 technical papers, four of them contributed by the Production Engineering Division of ASME.

Among the ASME contributors, E. V. Crane and F. P. Fehn, both of E. W. Bliss Company, wrote on the special problems created where a number of machines must be synchronized. Progress is being made in the application of electronic-sequencing principles to various control functions. Discovering where such control can be advantageous is a part of the problem. The mental hazard set up by the whole new language of programmed servo control has been a handicap.

A number of applications are discussed in the paper. They are scattered among mechanical and hydraulic presses, heavy machine tools, and rolling mills. At the end of the paper, the authors go beyond metalworking equipment to report the servo control of a 140-ft radio telescope, a tremendous mass that must be controlled under the variable conditions of wind pressure and temperature.

R. G. Chamberlain of Giddings and Lewis Machine Tool Company reported on the aircraft industry's adoption of numerical control of machine tools. Two systems of control—continuous path and discrete control—have been developed, and the differences are explained in the paper. The success of these control systems in the aircraft industry has opened new fields of application to machine tools.

H. L. Boppel, manager of the Autometrology Section, Sheffield Corporation, subsidiary of Bendix Aviation, presented a paper on automatic gaging. In addition to its obvious role in improving straightforward inspection operations, automatic gaging provides the basis for automatic machine control and automatic assembly. Mr. Boppel discussed some of the technical and economic considerations in utilizing automatic-gaging equipment, how multiple-machine arrangements can be handled, and the problem of debugging in automatic-gaging installations.

In the final ASME paper, J. F. Stoltz of the Hawthorne Works of Western Electric, took up automatic assembly, bringing out some of the factors which affect the feasibility of automatic manufacture and assembly of telephone products at the author's company. How does product design affect automatic assembly? What if you are dealing with an existing part which was not designed for automatic assembly? The author gave examples of tandemized operations on wire and cable products, automation of the wire-spring relay and of the dry-reed switch. In his conclusion, Mr. Stoltz said: "If the fully automatic manufacturing plant is to become a reality, it will materialize when the interrelated forces of prior mechanization and increased productivity have elevated our standard of living and the corresponding labor costs to a point where all manual operations are economically prohibitive."

The above four papers can be obtained through the ASME in the usual manner. The remaining eight papers may be obtained through the AIEE. They include reports on "Production Line Testing Programmed by Punched Cards," "Airframe Structural Integrity Testing—A Challenge In Automation," "The Operational Information System at Sterlington Steam Electric Station," "Problems

Encountered and Solved in Starting of Computer Control Systems," "User-Supplier Relationships in Automating a Steel Rolling Mill," "Airline Terminal Baggage Handling," "Automation as Applied to Book Warehousing and Shipping," and "Automatic Palletization Facilities at C. and H. Sugar Refining Corporation."

Under the guidance of a National Steering Committee, members from the Cleveland Sections of the three sponsoring societies assumed responsibility for acting as hosts in presenting the program organized by a National Program Committee. There was a luncheon arranged on each of the two conference days.

Availability List—Automatic Techniques

THE papers in this list are available in separate copy form until Feb. 1, 1961. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

60—AuT-1 Metal-Forming Under Electronic Sequencing, by E. V. Crane and F. P. Fehn
60—AuT-2 Numerical Control Developments, by R. G. Chamberlain
60—AuT-3 Automatic Inspection and Assembly, by Henry L. Boppel
60—AuT-4 Techniques and Economic Considerations Affecting Automatic Assembly of Telephone Products, by James F. Stoltz

ASME Maintenance and Plant Engineering Division and Materials Handling Division

A NONTRADE-CLASSIFICATION maintenance organization, proper test and inspection procedures, wear-resistant materials for reducing equipment maintenance, developments in maintenance welding, and specific procedures for industrial lighting, conveying equipment, lift and electric trucks were among the topics presented at the Maintenance and Plant Engineering Conference at the Chase Hotel, St. Louis, Mo., April 25–26, 1960, of The American Society of Mechanical Engineers. Sponsored by the ASME Maintenance and Plant Engineering and the Materials Handling Divisions, the conference also had the participation of the American Institute of Plant Engineers.

Technical Sessions

Organization. The maintenance system, developed from one company's work experience, provides an adequate crew of qualified "broad-scope maintenance men" in each building for all normal maintenance requirements. This is supplemented by a centralized maintenance pool. Extensive training programs develop the "broad scope" required. In many sections, two-man maintenance crews service automatic production and conveyer equipment. These men are capable of doing electrical, hydraulic, and mechanical work, plus the miscellaneous requirements usually related to maintenance-type operations. Costly disputes as to who performs a certain job have been eliminated and better employee morale has resulted from the reduced layoffs and rehirings.

Testing. Tests and inspections are vital for obtaining what a company wants and pays for in equipment, it was stated in another paper. Obtaining a properly qualified individual to take responsibility for an inspection program is of primary importance. He should have a thorough understanding of the problems encountered in design, construction, installation, and operation of the equipment which he is inspecting. Where suitable test codes or standards are not in existence, specific standards should be developed to insure adequate testing and inspection.

Wear. Recognizing wear as a problem regardless of industry type, another paper surveyed the metallurgical characteristics and general properties of a number of alloys. Properties needed for evaluation to provide the most economical alloy for an expected service life were considered. The importance of careful analysis of the operating conditions for proper selection was emphasized. Various methods of application can be used to achieve further economies.

Welding. Many of the welding methods introduced in industry to meet specific manufacturing needs have application in maintenance welding. For economy and reliability the author recommended oxyacetylene, metal-arc, nonconsumable-electrode, inert-gas-shield and to a limited extent submerged-arc welding methods. The various methods and some of the problems associated with their use were summarized.

Lighting. The paper on industrial lighting briefly reviewed the four fundamental factors involved in every visual task—size, contrast, brightness, and time—providing easily understood explanations of the way in which they enter a specific application. The maintenance factor is an important consideration in choosing the type for a particular installation, and maintenance procedures should also be carefully weighed.

Conveying. Designing preventive maintenance into machinery and equipment was recommended in the paper on the maintenance of bulk-material conveying equipment. Important maintenance areas for this "work horse" of industry were pinpointed.

Lift Trucks. The role of carefully kept maintenance records was stressed in the paper on maintenance-control procedures for industrial lift trucks. The type of records, how to keep them, and how to police them were points covered.

Electric Trucks. Planned maintenance programs were presented in a re-evaluation of the service given by maintenance groups for electric-powered trucks. Fundamental guide posts that can be applied to any electric-powered industrial-truck installation were presented, rather than fixed rules.

Forum. Questions and discussion topics were solicited during the conference for the annual Maintenance Forum. J. K. Bryan, past-chairman of the Division, served as chairman and moderator for the forum, with C. B. Briscoe, Mem. ASME, Water Commissioner of the City of St. Louis, serving as vice-chairman. The panel members were: J. C. Humphreys, vice-president, Day & Zimmermann, Inc., Philadelphia, Pa.; J. A. Rorick, manager, Operations and Maintenance, IBM Corporation, New York, N. Y.; W. C. Wallin, AIPE President, and chief, plant engineering department, Western Electric Company, Winston-Salem, N. C.; and G. V. Williamson, Fellow ASME, vice-president, Union Electric Company, St. Louis, Mo.

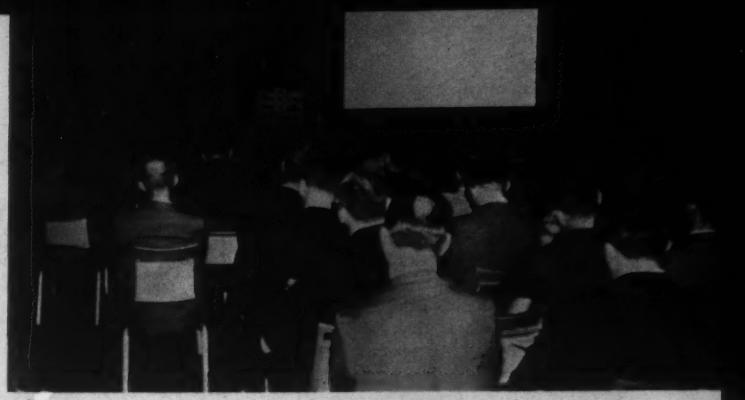
One question was how far to go in multiskill training. Some companies are developing general repairman classifications, and others are hiring high-school graduates as apprentices and giving on-the-job as well as night-school training.

Controlling the paper work for preventive-maintenance programs is being handled with IBM cards by a growing number of companies. Certain equipment-manufacturers' recommendations as to how often the equipment should be serviced were reported to be "too ambitious."

Safety monitors, who wear green badges and report all hazards to management, were reported as effective in promoting safety in maintenance.

K. P. Powers

G. V. Williamson



A Monday afternoon session audience hears papers on maintenance welding and industrial lighting

Join in Conference Held in St. Louis, Mo.—More Than 125 Attend

Employing engineering consultants was considered both advantageous and disadvantageous. One company, which had seven plants with corrosion problems all attacking them in different ways, engaged a consultant engineering firm. The specific recommendations which resulted have reduced costs and greatly lessened the corrosion problems.

Measuring maintenance performance came in for considerable comment. Among recommendations were the establishment of maintenance incentives, standardized job estimates, and time studies. Work sampling is popular in individual cases. One engineer reported that his company planned such sampling and, before the work could get under way, work output increased 10 per cent—simply because the workers knew of the plan. About 25 per cent of the companies represented at the Forum are employing some form of work sampling.

Banquet and Luncheons

ASME President Walker L. Cisler delivered the Banquet Address. B. G. Evans, chairman, ASME Maintenance and Plant Engineering Division, presided.

Mr. Williamson spoke on "Maintenance—A Basic Engineering Challenge" at the opening luncheon. K. P. Powers, vice-chairman, ASME Maintenance and Plant Engineering Division, presided.

AIPE President W. C. Wallin spoke on "The Broad Responsibilities of Plant Engineering" at the other luncheon. G. H. Sample, chairman, ASME St. Louis Section, presided.

Keep the Wheels Turning. President Cisler, who also is president of the Detroit Edison Company, spoke on "Keep the Wheels Turning" at the banquet.

He related how in former years maintenance was carried out practically on a calendar basis; but as demands increased and less and less time was available for periodic overhaul, recourse was made to special test procedures and new instruments—many of the latter being developed with the aid of the manufacturers. If the special tests indicate that the equipment is in good operating condition, management knows now that it is uneconomical to take machines off the line for overhaul on a calendar basis.

On the other hand, he pointed out if vibration is increasing, if pressures and temperatures are changing, if efficiency is deteriorating, we know today that the unit should be repaired, no matter how recently it may have been overhauled.

"In this way," Mr. Cisler said, "we are able to keep the wheels turning more reliably than ever before. We have applied a relatively small amount of highly skilled and technical endeavor—and we have eliminated a tremendous amount of expensive, unnecessary maintenance work that was formerly done by rote and routine."

Maintenance—A Challenge. At the Monday luncheon, Mr. Williamson, who is vice-president of Union Electric Company, St. Louis, Mo., cited numerous examples from his own experience, emphasizing that frequently the time and effort expended in improving maintenance will result in benefits many times greater than those resulting from, for example, improving operating efficiency.

Responsibilities—Plant Engineering. In the other luncheon address Mr. Wallin, AIPE President, and chief, plant engineering department, Western Electric Company, Winston-Salem, N. C., said the dual foundation for successful plant engineering is a combination of analysis and planning to furnish integrated, controlled engineering support. Plant-engineering functions include the development and maintenance of complex facilities and equipment representing extensive investments.

"The plant engineer is responsible for all physical aspects of over-all plant operation except product design and production. He designs and constructs, or contracts for and supervises, buildings, grounds, or additions and alterations; he makes and carries out plant and equipment layouts and supervises equipment installation. He designs, installs, and/or operates light, heat, power, sewage, water, communications, and transport facilities; and supplies safety, security, sanitary, and convenience provisions necessary for personnel production and property. He trains maintenance personnel, provides written operating instructions, and furnishes engineering know-how on all repair and maintenance activities on buildings, grounds, and equipment."

Mr. Wallin added: Obviously, today's plant engineer must devote serious thought to ways of coping with his increasingly complex responsibilities.

Availability List—Maintenance and Plant Engineering Conference

The papers in this list are available in separate copy form until Feb. 1, 1961. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

60—MPE-1 Maintenance-Control Procedures for Industrial Lift Trucks, by J. M. Squires

60—MPE-2 Maintenance Considerations for Electric Powered Industrial Trucks, by H. C. Bennett

60—MPE-3 Industrial Lighting, by Vern Kempf

60—MPE-4 Developments in Maintenance Welding, by W. H. T. Svanoe

60—MPE-5 Maintenance of Bulk-Material Conveying Equipment, by C. W. Cassells and E. J. Kamp

60—MPE-6 Maintenance Men — Important Today—A Necessity Tomorrow, by John Voderheide

60—MPE-7 Tests and Inspections: Are You Getting the Plant You Want, and Paid for? by R. M. Maxin

West Coast Applied Mechanics Conference, June 27–29, at California Institute of Technology

THE West Coast Conference of Applied Mechanics will be held June 27–29, 1960, on the campus of California Institute of Technology, Pasadena, Calif.

The conference is sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers and the Engineering Mechanics Division of the American Society of Civil Engineers.

Some of the subjects which will be covered during this widely diversified conference are elasticity, stress analysis, plasticity, vibration, oscillation, and thermodynamics. The technical sessions will be augmented by the Applied Mechanics Luncheon on Tuesday, June 28, 1960, and a tour of the University's Jet Propulsion Laboratory on Wednesday, June 29, 1960, at 1:00 p.m.

The technical program follows:

▶MONDAY, JUNE 27

General Lecture — 9:00 a.m.

Chairman: *W. T. Thomson*, Univ. of California, Los Angeles, Calif.

Engineering Applications of the Theory of Finite Elastic Deformation, by *J. N. Goodier*, Stanford Univ., Stanford, Calif.

Session 1 — 10:15 a.m.

On a Class of Nonlinear Axisymmetric Plate Problems, by *F. Essenburg*, Illinois Inst. of Tech., Chicago, Ill. (Paper No. 60—APMW-7)

The Additional Deflection of a Cantilever Due to the Elasticity of the Support, by *W. J. O'Donnell*, Westinghouse Bettis Atomic Power Lab, Pittsburgh, Pa. (Paper No. 60—APMW-3)

The Bending Stress Distribution at the Base of a Stationary Crack, by *M. L. Williams*, California Inst. of Tech., Pasadena, Calif. (Paper No. 60—APMW-14)

Session 2 — 2:00 p.m.

Chairman: *M. L. Williams*, California Inst. of Tech., Pasadena, Calif.

The Elastic Half-Space Subjected to Surface Tractions With Random Magnitude or Separation, by *A. Cemal Eringen* and *J. W. Dunkin*, Purdue Univ., Lafayette, Ind. (Paper No. 60—APMW-10)

Stress-Distributions Analyzed in Bispherical Co-ordinates, by *T. P. Michell*, Cornell Univ., Ithaca, N. Y.; and *J. A. Weese*, Boeing Airplane Co., Wichita, Kan. (Paper No. 60—APMW-4)

Thermal Stress Due to Disturbance of Uniform Heat Flow by an Insulated Ovaloid Hole, by *A. L. Florence* and *J. N. Goodier*, Stanford Univ., Stanford, Calif. (Paper No. 60—APMW-6)

Stresses in Layered Two-Dimensional Elastic Solids,[1] by *M. M. Lemcoe*, Southwest Res. Inst., San Antonio, Texas. (ASCE Paper)

▶TUESDAY, JUNE 28

General Lecture — 9:00 a.m.

Chairman: *S. B. Batdorf*, Aeronutronic, Newport Beach, Calif.

Stress-Strain Relations in Plasticity, by *P. M. Naghdi*, Univ. of California, Berkeley, Calif.

Session 3 — 10:15 a.m.

Thermal Stresses in an Elastic, Work-Hardening Sphere, by *Chintsun Hwang*, The National Cash Register Co., Hawthorne, Calif., and Univ. of Southern California, Los Angeles, Calif. (Paper No. 60—APMW-8)

Thermal Stresses in Reactor Shielding Due to Nonlinear Temperature Gradients,[1] by *M. L. Baron*, c/o Paul Weidlinger Consulting Engineer, New York, N. Y.; and *M. G. Salvadori*, Columbia Univ., New York, N. Y. (ASCE Paper)

Extrusion of Thick-Walled Cylinders Fabricated From Cold Bent Plates, by *Irwin Berman*, Foster Wheeler Corp., New York, N. Y. (Paper No. 60—APMW-2)

Luncheon — 12:00

Session 4 — 2:00 p.m.

Chairman: *M. V. Barton*, Space Technology Lab., Los Angeles, Calif.

Flexural Stress Waves in an Infinite Elastic Plate Due to a Suddenly Applied Concentrated Transverse Load, by *Julius Miklowitz*, California Inst. of Tech., Pasadena, Calif. (Paper No. 60—APMW-11)

On the Response of an Elastic Half Space to a Moving Blast Wave, by *J. W. Miles*, Univ. of California, Los Angeles, Calif. (Paper No. 60—APMW-9)

The Propagation of an Impulse Into a Viscous-Locking Medium, by *J. W. Miles*, Univ. of California, Los Angeles, Calif. (Paper No. 60—APMW-13)

Random Excitation of a Loaded Nonlinear String, by *T. K. Caughey*, California Inst. of Tech., Pasadena, Calif. (Paper No. 60—APMW-1)

[1] Paper contributed by West Coast Committee of ASCE. (Paper not available in print.)

▶WEDNESDAY, JUNE 29

Session 5 — 9:00 a.m.

Chairman: *G. W. Housner*, California Inst. of Tech., Pasadena, Calif.

Some Gyroscopic Oscillations, by *C. J. Thorne*, U. S. Naval Ordnance Test Station, China Lake, Calif. (Paper No. 60—APMW-15)

On the Behavior of Viscoelastic Plates in Bending,[1] by *G. E. Mase*, Michigan State Univ., East Lansing, Mich. (ASCE Paper)

Free Transverse Vibrations of a Solid Elastic Mass in an Infinitely Long, Rigid, Circular-Cylindrical Tank, by *J. H. Baltrukonis*, Space Technology Lab., Inc., Los Angeles, Calif. (Paper No. 60—APMW-12)

Effect of Small Hub Radius Change on Bending Frequencies of a Rotating Beam, by *Hsu Lo*, *J. E. Goldberg*, and *J. L. Bogdanoff*, Purdue Univ., Lafayette, Ind. (Paper No. 60—APMW-5)

Registration

Monday, June 27	8:15 a.m.–4:00 p.m.
Tuesday, June 28	8:30 a.m.–4:00 p.m.
Wednesday, June 29	8:30 a.m.–10:00 a.m.

Registration and all sessions will be held in Gates Laboratory.

Availability of Papers

ONLY *numbered* ASME papers in this program are available in separate copy form until April 1, 1961. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 40 cents to members of ASME, 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten, are $3 to members; $6 to nonmembers. Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Buffalo to Be Host City to Fourth National ASME-AIChE Heat Transfer Conference and Exhibit

THE fourth annual ASME-AIChE Heat Transfer Conference and Exhibit will be held at the Statler Hilton Hotel, Buffalo, N. Y , Aug. 14–17, 1960.

The technical program will be presented in twelve sessions and five panel discussions. Rounding out the program will be nine plant trips and tours tentatively scheduled and a varied and interesting program for the women guests.

▶MONDAY, AUGUST 15

Session 1 — 9:30 a.m.

Chairman: *S. W. Churchill*, AIChE, Univ. of Michigan

Co-Chairman: *S. Kopp*, ASME, Alco Products, Inc., Dunkirk, N. Y.

Temperature Depressions for Evaporating Spheres at Low Pressures, by *A. J. Madden* and *F. J. Halfen*, Univ. of Minnesota (AIChE Paper No. 1)

A Design Method for the Economical Drying of Moisture From Solids, by *H. T. Bates*, Kansas State Univ. (AIChE Paper No. 2)

An Analytical Study of Laminar Film Condensation, Part 1—Flat Plates; Part 2—Single and Multiple Horizontal Tubes,[1] by *M. M. Chen*, M.I.T.

Condensing Coefficients Inside a Horizontal Tube Near Atmospheric Pressure, by *J. A. Myers* and *H. F. Rosson*, Univ. of Kansas (AIChE Paper No. 3)

Heat Transfer by a Turbulently Flowing Fluid-Solids Mixture in a Pipe,[1] by *C. L. Tien*, Univ. of California

Session 2 — 9:30 a.m.

Chairman: *W. E. Hammond*, ASME, Air Preheater Corp., Wellsville, N. Y.

[1] Paper not available—see box on page 121.

Co-Chairman: *C. H. Gilmour*, AIChE, Union Carbide Chemicals Co., South Charleston, W. Va.

Some Aspects of the Melting Solution for a Semi-Infinite Slab, by *M. Altman*, Gen. Elec. Co., Philadelphia, Pa. (AIChE Paper No. 4)

Efficiency of Finned Annular Passages, by *A. D. Kraus*, Sperry Gyroscope Co., Great Neck, N. Y. (ASME Paper No. 60—HT-3)

On Unsteady State Heat Transfer in a Hollow Cylinder or Sphere, by *W. W. Clauson*, Illinois Inst. of Tech. (AIChE Paper No. 5)

Axial Temperature Distribution for Nuclear Reactor With Sinusoidal Space and Exponential Time Varying Power Generation,[1] by *W. O. Doggett* and *E. L. Arnold*, North Carolina State College

Temperature Regulation in a Bio-Satellite, by *K. L. Cappel*, The Franklin Inst. (ASME Paper No. 60—HT-6)

Open Panel Discussion 1—ASME 9:30 a.m.

Moderator: *P. A. Lottes*, Argonne National Lab., Lemont, Ill.

Heat Transfer in Advanced Reactor Concepts

Session 3 — 2:30 p.m.

Chairman: *J. G. Knudsen*, AIChE, Oregon State College

Co-Chairman: *S. P. Kezios*, ASME, Illinois Inst. of Tech.

Local Radial Effective Conductivity and Wall Effect in Packed Beds, by *R. F. Baddour* and *C. Y. Yoon*, M.I.T. (AIChE Paper No. 6)

The Relation Between the Transfer Coefficients and Thermal Fluctuations in Fluidized Bed Heat Transfer, by *H. S. Mickley, D. F. Fairbanks*, and *R. D. Hawthorn*, M.I.T. (AIChE Paper No. 7)

Heat Transfer With a Flowing Fluid Through Porous Media, by *D. W. Green* and *R. H. Perry*, Univ. of Oklahoma (AIChE Paper No. 8)

A Review of Fluid to Particle Heat Transfer in Packed and Moving Beds, by *T. G. Bowers* and *H. Reintjes*, Petrocarb, Inc., New York City (AIChE Paper No. 9)

Continuous Heat-Processing of Granular and/or Powdered Solids in Dry-State Fluidization, by *A. D. Holt*, Jeffrey Mfg. Co., Columbus, Ohio (AIChE Paper No. 10)

Session 4 — 2:30 p.m.

Chairman: *H. A. Johnson*, ASME, Univ. of California

Co-Chairman: *R. F. Fremed*, AIChE, McGraw Hill Book Co., New York, N. Y.

Thermal Conductivity Studies With the Powell Method,[1] by *A. I. Dahl* and *D. W. Jones*, Gen. Elec. Co., Schenectady, N. Y.

Quantitative Evaluation of Edge Losses and Contact Resistances in the Determination of Thermal Diffusivity of Solid Materials by an Unsteady State Method, by *A. A. Armstrong* and *K. O. Bealty* (AIChE Paper No. 11)

The Viscosity of Steam and Water at Moderate Pressures and Temperatures,[1] by *J. R. Moszynski*, Case Inst. of Tech.

Viscosity, Thermal Conductivity, and Prandtl Number of Carbon Dioxide-Air Mixtures,[1] by *J. L. Novotny* and *T. F. Irvine, Jr.*, Univ. of Minnesota

P-V-T Data for Water in the Critical Region,[1] **Part 1—A Survey; Part 2—Smoothed Relations Derived From the Experimental Measurements,** by *E. S. Nowak, R. J. Grosh*, and *P. E. Liley*, Purdue Univ.

Open Panel Discussion 2—AIChE 8:00 p.m.

Discrepancies Between Design Procedures and Plant Operations (AIChE Paper No. 12)

Moderator: *D. Q. Kern*, D. Q. Kern Associates, Cleveland, Ohio.

Panelists: *D. J. Bergman*, Universal Oil Products, Des Plaines, Ill.
C. H. Brooks, Sun Oil Co., Philadelphia, Pa.
C. H. Gilmour, Union Carbide Chemicals Co., South Charleston, W. Va.
A. C. Mueller, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del

▶TUESDAY, AUGUST 16

Session 5 — 9:00 a.m.

Chairman: *A. S. Foust*, AIChE, Lehigh Univ.

Co-Chairman: *S. Ostrach*, ASME, NASA, Cleveland, Ohio

Dimensional Analysis and Natural Convection, by *J. D. Hellums* and *S. W. Churchill*, Univ. of Michigan (AIChE Paper No. 13)

[1] Paper not available—see box on this page.

Availability of Papers

ASME Papers

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AIChE Papers

For AIChE papers (numbered consecutively) write to Joel Henry, American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y.

A Theoretical Analysis of Laminar Natural Convection Heat Transfer to Non-Newtonian Fluids, by *A. Acrivos*, Univ. of California (AIChE Paper No. 14)

Transient Natural Convection From Vertical Elements,[1] by *B. Gebhart*, Cornell Univ.

The Influence of Sound on Free Convection From a Horizontal Cylinder,[1] by *R. N. Fand* and *J. Kaye*, M.I.T.

An Experimental Study of the Effects of Strong Progressive Sound Field on Free Convection From a Horizontal Cylinder,[1] by *A. L. Sprott, J. P. Holman*, and *F. L. Durand*, Wright Air Development Center, Wright Field, Ohio

Correlation of Convection Heat Transfer in Confined Horizontal Layers, by *J. L. O'Toole* and *P. L. Silverston*, Newark College of Engineering (AIChE Paper No. 15)

Session 6 — 9:00 a.m.

Chairman: *J. F. Wachunas*, ASME, The Babcock & Wilcox Co., Alliance, Ohio.

Co-Chairman: *E. H. Young*, AIChE, Univ. of Michigan

Fluid Friction and Heat Transfer in Cylindrical Pipes: Relationship Between Lumped and Distributed Parameters, by *J. C. Smith*, Cornell Univ. (AIChE Paper No. 16)

Heat Transfer to Longitudinal Laminar Flow Between Cylinders,[1] by *E. M. Sparrow, A. L. Loeffler, Jr.*, and *H. A. Hubbard*, NASA, Cleveland, Ohio

Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli,[1] **Part 1—Stationary Flow; Part 2—Pulsating Flow,** by *I. Shai* and *Z. Rotem*, Israel Inst. of Tech., Haifa, Israel

Heat Transfer and Pressure Drop in an Annular Gap With Surface Spoilers,[1] by *G. A. Kemeny* and *J. A. Cyphers*, Westinghouse Elec. Corp., Pittsburgh, Pa.

Rates of Heat Transfer From Short Sections of an Isothermal Pipe, by *A. A. Faruqui* and *J. G. Knudsen*, Oregon State College (AIChE Paper No. 17)

The Effect of Density Variation on Heat Transfer in the Critical Region, by *Y. Y. Hsu* and *J. M. Smith*, Northwestern Univ. (ASME Paper No. 60—HT-8)

Open Panel Discussion 3—ASME 9:30 a.m.

Moderator: *R. Powers*, Sylvania-Corning Nuclear Corp.

Oxide Fuel Heat Transfer

Session 7 — 2:00 p.m.

Chairman: *J. W. Westwater*, AIChE, Univ. of Illinois

Co-Chairman: *S. Levy*, ASME, Gen. Elec. Co., San Jose, Calif.

Analysis and Interpretation of the Shape of the Boiling Curve, by *K. O. Beatty*, North Carolina State College (AIChE Paper No. 18)

Transition Boiling Heat Transfer, by *P. J. Berensen*, M.I.T. (AIChE Paper No. 19)

On the Mechanism of Subcooled Nucleate Boiling, Part 1—Preliminary Considerations; Part 2—Sequential Rate Process Model, by *S. G. Bankoff*, Northwestern Univ. (AIChE Paper Nos. 20, 21)

Burnout in Turbulent Flow—A Droplet Dispersion Model,[1] by *K. Goldmann, H. Firstenberg*, and *C. Lombardi*, Nuclear Development Corp. of America, White Plains, N. Y.

A Photographic Study of Pool Boiling in the Region of the Critical Heat Flux, by *R. Cole*, NASA, Cleveland, Ohio (AIChE Paper No. 22)

Heat Transfer, Burnout, and Pressure Drop for Water in Swirl Flow Through Tubes With Internal Twisted Tapes, by *W. R. Gambill, R. D. Bundy*, and *R. W. Wansbrough*, Oak Ridge National Lab., Oak Ridge, Tenn. (AIChE Paper No. 23)

Session 8 — 2:00 p.m.

Chairman: *G. M. Dusinberre*, ASME, Pennsylvania State Univ.

Co-Chairman: *C. H. Brooks*, AIChE, Sun Oil Co., Philadelphia, Pa.

Radiation Heat Transfer in a Spherical Enclosure Containing a Participating Heat-Generating Gas, by *E. M. Sparrow, C. M. Usiskin*, and *H. A. Hubbard*, NASA, Cleveland, Ohio (ASME Paper No. 60—HT-9)

Analysis, Results, and Interpretation for Radiation Between Some Simply Arranged Gray Surfaces, by *E. M. Sparrow, J. L. Gregg, J. V. Szal*, and *P. Manos*, NASA, Cleveland, Ohio (ASME Paper No. 60—HT-4)

Radiant Heat-Transfer Analysis of a Furnace or Other Combustion Enclosure,[1] by *J. T. Bevans*, Shell Development Co., Emeryville, Calif.

Radiant Heat Transfer; Part 1—From Flat Plate Uniformly Heated on One Edge; Part 2—From Tapered Fin With Constant Temperature Gradient, Uniformly Heated at Root Section, by *D. B. Mackay* and *E. L. Leventhal*, North American Aviation, Inc., Downey, Calif. (AIChE Paper Nos. 24, 25)

Radiative Transport Within an Ablating Body, by *L. P. Kadanoff*, AVCO Research Lab., Everett, Mass. (ASME Paper No. 60—HT-2)

Investigation of the Performance of a Shop Assembled Vaporizer Using Dowtherm, by *J. H. Born, Jr.*, and *M. L. Jones*, Foster Wheeler Corp., New York, N. Y. (AIChE Paper No. 26)

Open Panel Discussion 4—ASME 8:00 p.m.

Moderator: *R. M. Armstrong*, R. M. Armstrong Co., West Chester, Pa.

Heat-Exchanger Standardization

▶WEDNESDAY, AUGUST 17

Session 9 — 9:00 a.m.

Chairman: *M. T. Cichelli*, AIChE, E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

Co-Chairman: *T. F. Irvine, Jr.*, ASME, North Carolina State College

Heat Transfer to Laminar Flow Across a Flat Plate With a Nonsteady Surface Temperature, by *R. D. Cess*, Westinghouse Elec. Corp., Pittsburgh, Pa. (ASME Paper No. 60—HT-7)

Film Cooling: Part 1—With Multiple Continuous Slots; Part 2—With Multiple Rows of Discrete Louvers,[1] by *J. H. Chin, S. C. Skirvin, L. E. Hayes*, and *F. Burggraf*, Gen. Elec. Co., Cincinnati, Ohio

Velocity Distributions, Temperature Distributions, Effectiveness, and Heat Transfer for Air Injected Through a Tangential Slot Into a Turbulent Boundary Layer,[1] by *J. P. Harnett, R. C. Birkebak*, and *E. R. G. Eckert*, Univ. of Minnesota

Two-Phase Slug Flow,[1] by *P. Griffith* and *G. B. Wallis*, M.I.T.

Heat Transfer and Pressure Drop in Two-Phase Flow, by *K. E. Lunde*, Yuba Consolidated

Industries, Palo Alto, Calif. (AIChE Paper No. 27)

Forced Convection Heat Transfer From an Isothermal Sphere to Water, by *G. C. Vliet* and *G. Leppert*, Stanford Univ. (ASME Paper No. 60—HT-5)

Session 10 — 9:00 a.m.

Chairman: *W. M. Rohsenow*, ASME, M.I.T.

Co-Chairman: *D. Miller*, AIChE, Argonne National Lab., Lemont, Ill.

Hydraulic Instability in a Natural Circulation Loop With Net Steam Generation at 1000 Psia,[1] by *S. Levy* and *E. S. Beckjord*, Gen. Elec. Co., San Jose, Calif.

Analysis and Measurement of Flow Oscillations, by *E. R. Quandt*, Westinghouse Elec. Corp., Pittsburgh, Pa. (AIChE Paper No. 28)

Thermal Stress Oscillations Induced by Transition Boiling,[1] by *V. S. Arpaci* and *C. E. Jones*, The Babcock & Wilcox Co., Alliance, Ohio

Pool Boiling in an Accelerating System,[1] by *H. Merte, Jr.*, and *J. A. Clark*, Univ. of Michigan

An Experimental Study of Boiling in Reduced and Zero Gravitational Fields, by *C. M. Usiskin* and *R. Siegel*, NASA, Cleveland, Ohio (ASME Paper No. 60—HT-10)

Measured Variation in Local Surface Temperatures in Pool Boiling of Water,[1] by *S. T. Hsu* and *F. W. Schmidt*, Univ. of Wisconsin

Open Panel Discussion 5—ASME 9:30 a.m.

Moderator: *R. B. Scott*, U. S. Bureau of Standards, Washington, D. C.

Cryogenic Heat Transfer

Panelists: *T. Buckhold*, Gen. Elec. Co., Schenectady, N. Y.
R. Glover, Univ. of North Carolina
W. Kahl, Linde Co., Tonawanda, N. Y.
C. McKinley, Air Products Co., Allentown, Pa.

Session 11 — 2:00 p.m.

Chairman: *A. C. Mueller*, AIChE, E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

Co-Chairman: *J. A. Clark*, ASME, Univ. of Michigan

High-Intensity Natural Convection Heat Transfer Near the Critical Point, by *C. F. Bonilla* and *L. A. Sigel*, Columbia Univ. (AIChE Paper No. 29)

Natural Circulation Tests With Water at 800 to 2000 Psia Under Nonboiling, Local Boiling and Bulk Boiling Conditions,[1] by *O. J. Mendler, A. S. Rathbun, N. E. Van Huff*, and *A. Weiss*, Westinghouse Elec. Corp., Pittsburgh, Pa.

An Experimental Investigation of Partial Film Boiling With Water at Elevated Pressures in a Round Tube, by *E. C. King, J. B. Donough*, and *W. Milich*, Mine Safety Applicances Research Corp., Gallery, Pa. (AIChE Paper No. 30)

The Effect of Trace Additives on the Heat Transfer to Boiling Isopropanol, by *T. Dunskus* and *J. W. Westwater*, Univ. of Illinois (AIChE Paper No. 31)

Nucleate-Boiling Studies With Aqueous ThO_2 Slurries, by *D. G. Thomas*, Oak Ridge National Lab., Oak Ridge, Tenn. (AIChE Paper No. 32)

Determination of Boiling Film Coefficient for a Heated Horizontal Tube in Water-Saturated Wick Materials,[1] by *W. D. Allingham* and *J. A. McEntire*, Boeing Airplane Co., Seattle, Wash.

Session 12 — 2:00 p.m.

Chairman: *K. A. Gardner*, ASME, Yuba Consolidated Industries, Inc., Palo Alto, Calif.

Co-Chairman: *E. C. Ashton, Jr.*, AIChE, Downington Iron Works, Downington, Pa.

Wall Temperature and Heat-Flux Measurement in a Round Tube, by *A. E. Morgan, Jr.*, and *R. A. Carlson*, U. S. Department of Agriculture, Albany, Calif. (ASME Paper No. 60—HT-1)

Shell and Tube Heat Exchangers: Effect of Bypass and Clearance Streams on the Main Stream Temperature,[1] by *B. E. Short*, Univ. of Texas

Possibilities of Using Plastic Film as an Economical Substitute for Metal in Heat Exchangers, by *J. M. Weaver*, Chicago, Ill. (AIChE Paper No. 33)

Optimization of a Sandwiched Thermoelectric Device,[1] by *B. W. Swanson, E. V. Somers*, and *R. R. Heikes*, Westinghouse Elec. Corp., Pittsburgh, Pa.

Scraped-Surface Heat Exchangers; Part 1—Power Consumption; Part 2—Heat Transfer, by *A. H. P. Skelland, L. S. Leung, D. R. Oliver*, and *S. Tooke*, Illinois Inst. of Tech. (AIChE Paper Nos. 34, 35)

An Experimental Investigation of the Suitability of JP-4 Fuel for Regenerative Cooling of a Hypersonic Ramjet Engine,[1] by *R. A. Dutton*, Marquardt Corp., Van Nuys, Calif.

Selection and Use of High-Temperature, Leak-Proof Canned Pumps, by *H. A. Thornton* and *A. D. Fell, Jr.*, Fostoria Corp., Huntingdon Valley, Pa. (AIChE Paper No. 36)

[1] Paper not available—see box on page 121.

Pamphlet Papers: Prices Increased

RISING editorial, paper, and production costs have forced the Publications Committee to increase prices for pamphlet copies of technical papers. At the same time, the increase will also provide price uniformity with our sister societies with whom we hold a number of Joint Conferences. Effective with meetings and conferences held after July 1, 1960, therefore, prices of pamphlet papers will be increased to $1 to nonmembers; 50 cents to ASME members. Prices for books of ten coupons will be $8 to nonmembers; $4 to ASME members.

The 1960 Joint Automatic Control Conference, September 7–9

THE first annual Joint Automatic Control Conference will take place on September 7–9 on the campus of the Massachusetts Institute of Technology. The objective of the JACC is to establish a single high-level technical conference devoted exclusively to the theory and application of automatic control techniques and equipment. This unique venture recognizes the growing stature and importance of the field of instrumentation and control within the broader interests of the five co-operating societies. The JACC sponsors are: The American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Instrument Society of America. ASME is the host society for 1960.

The program will total 18 technical sessions, with three sessions going on simultaneously during the six morning and afternoon periods. The program committee will integrate papers and schedule their presentation according to subjects of prime interest to conference attendees. Among the 18 sessions will be three sessions on sampled data and adaptive control, three on process dynamics, four on computer control, and three on control components. A special feature will be a first-hand report on the proceedings of the first International Congress of the International Federation of Automatic Control to be held in Moscow this June. This report will be given on the Thursday evening of the JACC conclave.

Accommodations for 250 attendees (and wives) will be available on the M.I.T. campus. For further information and for a copy of the advance program to be ready this summer, write to the JACC General Chairman, Wm. D. Archibald, Energy Control Company, 5 Beekman Street, New York 38, N. Y.

ASME COMING EVENTS

June 5–9
ASME Semi-Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, Texas

June 20–22
ASME Applied Mechanics Conference, The Pennsylvania State University, University Park, Pa.

June 27–29
ASME West Coast Applied Mechanics Conference, The California Institute of Technology, Pasadena, Calif.

August 15–17
ASME-AIChE Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y.

September 7–9
ASME Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass.

September 15–16
ASME-AIEE Engineering Management Conference, Morrison Hotel, Chicago, Ill.

September 18–21
ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans, La.

September 21–23
ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

October 9–12
ASME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.

October 17–19
ASME-ASLE Lubrication Conference, Statler Hilton Hotel, Boston, Mass.

October 24–25

ASME-AIME Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

November 27–December 2

ASME Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(*For Meetings of Other Societies see page 110*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers 50 cents; to ASME Members, free.

PEOPLE

Honors and Awards. Robert C. Allen, Fellow ASME, director of engineering, Industries Group, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., and Alexander G. Christie, Hon. Mem. ASME, emeritus-professor of mechanical engineering, The Johns Hopkins University, Baltimore, Md., received distinguished-service citations from the University of Wisconsin for outstanding accomplishments in their fields.

The 1959 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Lee A. Kilgore, manager of engineering at Westinghouse Electric Corporation, East Pittsburgh Division. The medal, awarded to a member of AIEE who has shown meritorious achievement in the development of electric apparatus or machinery, will be presented at the summer general meeting of the Institute at Atlantic City, N. J., June 20.

The American Welding Society conferred many awards at its annual meeting in April. B. E. Rossi, Mem. ASME, editor of *The Welding Journal*, was named winner of the Samuel Wylie Miller National Award for his outstanding contributions toward the advancement of welding and cutting.

Honorary membership in AWS was conferred on R. D. Thomas, Jr., president of the Arcos Corporation, Philadelphia, Pa.; and F. L. Plummer, Mem. ASME, National Secretary of AWS. The awards were made in recognition of exceptional accomplishments in the development of the welding art.

The AWS National Meritorious Service Award went to J. E. Dato, Electric Welding Sales Manager of the Linde Division of Union Carbide Corporation; and to F. W. Davis, Mem. ASME, Technical Consultant to the Southwest Research Institute, for their outstanding service to AWS. Mr. Davis until recently had been with the U. S. Atomic Energy Commission for nine years.

Among those who received the AWS District Meritorious Certificate Awards, given as means of recognizing those who have performed some definite or unusual service to a section, district, or to the society, were Sidney Low, Mem. ASME, Chapman Valve Manufacturing Company, Indian Orchard, Mass.; and Gustav O. Hoglund, Mem. ASME, Aluminum Company of America, New Kensington, Pa.

Henry A. Druding, chief engineer of the Port of New York Authority, received the Engineer of the Year Award from the New Jersey Society of Professional Engineers. William A. Hughes, retired chairman of the New Jersey Bell Telephone Company, received the society's Citizen of the Year Award.

Frederick D. Braddon, creator of the gyrocompass that guided the atomic submarines *Nautilus* and *Skate* under the ice cap of the North Pole, was named recipient of the Elmer A. Sperry Award for outstanding contributions to the field of transportation. Mr. Braddon is chief engineer of the Marine Division of Sperry Gyroscope Company, founded by the man for whom the award is named. The award is sponsored by ASME, AIEE, SAE, and SNAME.

American Foundrymen's Society honored three leaders in the metals castings industry at its annual meeting. Samuel F. Carter, Jr., American Cast Iron Pipe Company, Birmingham, Ala., received the Wm. H. McFadden Gold Medal for exceptional contributions to AFS and the castings industry in the fields of cupola melting, electric steel melting, and control. W. W. Levi, metallurgical consultant, Radford, Va., received the Thomas W. Pangborn Gold Medal for outstanding contributions to the society and the ferrous castings industry in the field of cupola metallurgy, research, and operation. The Joseph S. Seaman Gold Medal went to T. D. Stay, technical adviser, Reynolds Metals Company, Cleveland, Ohio, for outstanding technical contributions to the society and light-metals industry over many years, particularly in alloying and castings.

Presentation of the Atoms for Peace Awards, set up by the Ford Motor Company in response to President Eisenhower's suggestion that incentive be

(*Continued on page 125*)

At SAM-ASME Management Engineering Conference in New York City (see MECHANICAL ENGINEERING, May, 1960, p. 121) Prof. Leo B. Moore, left, of M.I.T., receives Gilbreth Medal for advancement of management from SAM President D. L. Bibby

W. X. Stanhaus, left, president of Spector Freight Systems, is presented with SAM Material Handling Award by Warren King, vice-president, FLEET OWNER

SAM President Bibby, left, vice-president, Remington Rand Division, Sperry Rand Corporation, presents silver tray to Phil Carroll, Fellow ASME, as retiring chairman of SAM board

Conducted for the National Junior Committee

J.R. BERENDES[1]

JUNIOR FORUM

A Career in Sales Engineering

By Robert J. Williams[2]

How Can You Tell Whether a Career in Sales Engineering Is the One for You? To reply "if you like people" is only a partial answer. A more considered answer requires a certain amount of self-analysis in relation to the requirements of sales activity which are generally accepted as necessary to success. Even comparing yourself with the stereotyped conception of a salesman will not yield the correct answer. For one reason, the picture of a salesman as a flamboyant, ribald individual with the alcohol capacity of a brewmaster most often turns out to be a myth.

There are some guideposts which will help you to evaluate yourself. It is fairly well agreed that a person aspiring to any type of sales should be an extrovert more so than an introvert. The generalization that engineers tend to be introverts probably has no foundation, so it need not be taken into account. The sales engineer should have a genuine desire to meet people, learn about them, and want to do something for them. Beyond his product knowledge, the sales engineer's most useful asset is his appreciation of human nature. He should be a student of amateur psychology and know that there are more ways to a man's heart than those employed by women. While the product will be real, the techniques used in selling are as intangible as in the sale of insurance.

Where Does the Sales Engineer Fit Into the American Commercial Scheme? Consider the following areas of specialized proficiency:

Laborer	muscle
Tradesman	skill
Engineer	technical knowledge
Management	judgment
Sales Engineer	?

[1] Sales Representative, Combustion Engineering, Inc., Chicago, Ill. Assoc. Mem. ASME.

[2] Power Apparatus Sales Engineer, Westinghouse Electric Corporation, Sturtevant Division, Chicago, Ill. Assoc. Mem. ASME.

It is suggested a sales engineer's forte should be "articulation." In the broad sense, articulation is his interpretation and expression of the many roles he acts as a representative to his customers. His chief activity may be to send out quotations and solicit orders, but the sales engineer is most effective and better received if he represents his company's role as essential to his customers' continued production and as one that assumes their problems. The sole purpose of a sales engineer's research and development department is to bring out new products to pre-empt competition and increase profits, but he should represent it as contributing to his customer's welfare. The sales engineer is a commercial ambassador and the total effect of his communication with his customers forms the image they have of his employer. In the long run, this probably influences more than any other factor the business a supplier receives.

Why Are Engineers Used in Sales? Isn't that a waste of technical training and skill needed in production? Even though sales engineers don't engineer, they do use engineering. They represent companies filling engineering needs with engineered products. These products are specified, bought, installed, and operated by engineers. It is only natural that they be sold by engineers. To have it otherwise would be like a defendent pleading his own case and arguing a point of law with the judge.

Often during a sale, a technical representative or engineer from the supplier's factory may be summoned to visit the customer and answer design questions. This situation suggests more of a lack of engineering capacity on the salesman's part than a waste of it.

Every product involves some engineering in design, application, and production so one could not say the sales engineer is deprived of the opportunity to develop his engineering skill to the limit until he has become his company's most prolific product idea man. As a matter of fact, it is one of the sales engineer's prime responsibilities to respond to changing market product needs and supply the feedback to signal the direction of his company's development efforts.

The creativity and teamwork involved in a "practicing" engineer's career can be both satisfying and stimulating to him. But consider also the range of experiences and excitement in sales engineering.

As in no other field, the sales engineer can become emotionally involved in his work. Few draftsmen, engineers, machinists, or order service clerks feel the competitive struggle that exists with counterparts in their competitors' organizations. The sales engineer enters the arena of this struggle daily. If you are a poor loser, sales is definitely not for you. Unless you have a monopoly, you will always lose more often than win, and it takes a special adjustment not to become defeated by this experience. It can really be a cruel world and your competitors are ever obliging to remind you of it. On the other hand, the thrill of receiving an order more than compensates for losses.

There are some areas where sales engineers have agreeable working conditions which require personal discipline to satisfy the responsibility associated with them. He has complete freedom of movement and flexibility of time not enjoyed by other departments. If someone needs to tell him when to visit a customer, he won't be around long. He decides how much time and effort he spends on any one account and what kind of sales campaign or approach he will direct to an account. In sales, as in no other department, a man has the opportunity to use his own resourcefulness and initiative. In sales there is no formula to use nor strategy to follow that will insure success on a given sale. The salesman must do a little sleuth work and discover the factors that he can use to form a plan utilizing his company's total resources to influence the customer in his favor.

Few sales engineers realize what a unique privilege they have with the expense account, especially the entertaining budget. What other employee in another department has any kind of discretionary allowance? Here again, there is an attendant responsibility to use it to the best interest of your employer. Its use is worthy of more consideration and planning than is often given. It cannot be looked on as a direct means of obtaining an advantage in a sales negotiation but as an aid to expressing the special relationship your customer has in the life of your employer.

With a slight use of his imagination, the sales engineer can even construe his operation as his own separate business enterprise, using his own sales quota and

expected expense-to-sales ratio for the break-even point. He can scale down his company's national sales objective to his own territory and relate his performance to the company's profit and loss with their sobering consequences. This kind of experience is virtually impossible to an engineer or production employee. If you ever consider going into business for yourself, sales would give you a free try to see if you can take it.

Sales engineering provides a rare opportunity for the individual to broaden himself that is unmatched in other technical endeavors. In the course of time he will be exposed to many different customers, industries, products, processes, and areas of the country. He will meet a multitude of people with their different personalities and interests, requiring him to be adaptable, widely read, and with far-ranging interests himself. The sales engineer, through participation in professional society activities as well as in customer entertaining, will have a greater opportunity to improve his social skills and enjoy the increased self-confidence resulting.

In conclusion, do not underestimate a career in sales engineering. If it looks good to you, the rewards will not be disappointing. Your ability will be recognized by promotion in sales as quickly as in engineering and the monetary compensations are equally good, if not better than in engineering.[3]

Chairman's Corner

The Call of an Engineer

A *call* is generally recognized as a strong feeling within an individual which compels him to enter a particular life work. There is one call that is greater than the occupational call. It is the call to live. To live not for oneself. But to live to give. In giving you will receive. To get all you can out of the turnip you must put all you can into it, but not for selfish purposes.

What has been said here about life also is true when applied to one's occupation. And when a man performs his job with a spirit of serving others for the sake of service, he becomes a truly professional man.

You who are graduating this month took engineering degrees for many varied reasons. As you embark on engineering careers there are as many reasons for accepting the jobs you take. (There is, fortunately, no one job that all new graduates seek.) Probably you look forward with pride to attaining the title of engineer because of what you visualize it implies. However, you will experience some disillusionment. You will find, first hand, that engineering as a profession still has much growing to do. Why? One reason is most of us are really "out for ourselves" rather than out to serve others. This might be excusable, humanly speaking, if the supply of engineers far exceeded the demand. Yet this is not the case.

The engineer who has achieved professional stature recognizes his need and responsibility to serve others. ASME offers opportunities for service. Yet only some ten per cent of the membership take an active part.

The call of an engineer is a call to service. Let's make service synonomous with engineer.

Why not get off on the right foot today? Make up your mind to take an active part in ASME. Look over the list and let me know what interests you most. Nominations are made up until August 1, 1960. Appointments become effective in early December.

N. J. Viehmann,[4] Chairman,
National Junior Committee

For the Young Associate Member

1 On the National Level

A Representative on a standing ASME committee

Title: Junior Representative
Term: Two years
Number of Openings: Two for each committee listed:
- Constitution & By-Laws
- Publications
- Membership Development
- Meetings
- Professional Divisions:
  - Power Committee
  - Industry Committee
  - Basic Engineering Committee

There is one junior representative for the Board on Education.

B Representative to the National Junior Committee

Title: Executive Committee Member
Term: Five years
Openings: There are ten committee members, two appointed each year.

C Producer and director of a Junior Session at either of the two national meetings held each year by the Society

Title: Reporting Representative
Term: Approximately one year
Openings: Two per year.

There are also opportunities to participate as a speaker or as a Session Chairman or Vice-Chairman.

2 On the Regional Level

A Representative to a standing regional committee

Title: Junior Representative
Term: Two years
Openings: As determined by the Regional Vice-President.
The bracketed figure indicates the customary number:
- Membership Development Committee [2]
- Student Sections Committee [1]
- Civic Affairs Committee [1]

B Member of a regional young Associates committee

Term: Dependent upon the by-laws of each regional committee.
Openings: Usually two for each section in the region.
To date two such committees have been formed and are in full swing, (Regions V and VI). In Regions I, II, and VIII an Associate Member has been appointed to form a committee.

People

(Continued from page 123)

provided for international efforts to develop nuclear energy for peaceful purposes, were made at the National Academy of Science in Washington, D. C., May 18. Recipients of the 1959 awards are Dr. Leo Szilard, professor of biophysics, the University of Chicago; and Dr. Eugene P. Wigner, professor of mathematics, Princeton University. Dr. Alvin M. Weinberg, director of the Oak Ridge National Laboratory, Oak Ridge, Tenn.; and Dr. Walter H. Zinn, vice-president of Combustion Engineering, Inc., are the 1960 choices. All four men had made contributions in the development of nuclear reactors.

New Appointments. Theodore C. DuMond, Affiliate ASME, has been appointed manager of National and Regional Metal Congresses of the American Society for Metals. He has also been named director of Membership and Chapter Relations for the society.

Captain Paul J. Burr, USN (Ret), was recently appointed technical services director of the Institute of the Aeronautical Sciences, a newly created staff post responsible for the compilation and distribution of information in all areas of aerospace technology.

[3] The opinions stated are those of the author and not necessarily those of the Westinghouse Electric Corporation.

[4] Product Planning Engineer, Western Electric Company, North Andover, Mass. Assoc. Mem. ASME.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Friday, April 8, 1960. There were present: Walker L. Cisler, President; T. J. Dolan, W. H. Larkin, H. N. Muller, and R. B. Smith of the Executive Committee; V. W. Smith, a Director; E. J. Schwanhausser, Finance Committee Chairman; T. A. Marshall, Jr., Senior Assistant Secretary; W. E. Letroadec, W. E. Reaser, S. A. Tucker, and J. D. Wilding, Assistant Secretaries; J. J. Jaklitsch, Jr., Editor; H. I. Nagorsky, Controller; D. B. MacDougall, Associate Head, Field Service; and Benjamin Theroux. O. B. Schier, II, Secretary, was attending the Region IV RAC Meeting in Columbia, S. C.

ASME Staff Members. Recognition of Long Service by Staff. The members of the staff who have completed more than 25 years of service were recognized by the Executive Committee of Council who extended to Marie Mullan and Benjamin Theroux, members of the staff for 40 years, sincere appreciation of their loyal and faithful services and their valuable contribution to the success of the Society and presented each with an honorarium.

Research Executive Committee. Supplement No. 2 to Research Agreement 7SP-6. In accordance with the Delegation of Authority given to the Board on Technology by the Council on Nov. 30, 1959, and with the approval of the Research Executive Committee, the Secretary signed Supplement No. 2 to Research Agreement 7SP-6 with the University of Michigan, extending the expiration date for a period of one year to Jan. 31, 1961, and increasing the maximum amount to be paid by $20,000—from $20,000 to $40,000.

Boiler and Pressure Vessel Committee. ISO/TC-11 Meetings. The Council authorized J. D. Wilding, Secretary of the Boiler and Pressure Vessel Committee, to attend the meetings of ISO/TC-11 in Europe in June, 1960.

Publications Committee. The following actions taken by the Publications Committee on March 22, 1960, under the Delegation of Authority, were reported:

Special Publications. In reviewing the breakdown of the income and expenses for various parts of the publishing program of the Society, the Publications Committee, in an effort to reduce the deficit in publishing "general publications," instructed the staff to consider the estimated total cost of optional publications as including all direct and indirect costs, and to refer to the Publications Committee for consideration of subsidy or other means of support any proposed publication that does not show prospects of recovering its total cost.

Pamphlet Papers. After comparing the prices of ASME pamphlet papers with those of sister societies, particularly the societies with whom we work on joint conferences, the Publications Committee voted that for meetings and conferences, held after July 1, 1960, the price of pamphlet papers be increased to 50 cents to members and $1 to nonmembers; and the price of books of ten coupons to $4 to members and $8 to nonmembers.

Mechanical Engineering Clubs. There are several mechanical engineering clubs in engineering schools where it is anticipated that the mechanical engineering curriculums will be accredited by ECPD within three years, thus leading to the establishment of new ASME Student Sections. Members of such groups, in some cases, have expressed a wish to subscribe to MECHANICAL ENGINEERING.

In a generalization of procedure already established by the Council on March 1, 1957, for two universities, the Publications Committee authorized students who are members of mechanical engineering clubs which are sponsored by a local ASME Section be permitted to subscribe to MECHANICAL ENGINEERING for 12 issues at the current rate of Student Member dues ($5 per year) and such subscriptions be endorsed as special student subscriptions by an ASME member who is on the faculty at the particular school (preferably the head of the mechanical engineering department).

Professional Divisions. Applied Mechanics Division European Trip. The Applied Mechanics Division is negotiating with TWA for a charter flight from New York to Milan, Italy, for those planning to attend the International Congress of Applied Mechanics in Stresa, Italy, Aug. 31 to Sept. 10, 1960.

Sections. Long Island Section. The Council authorized Section status for the Long Island Subsection of the Metropolitan Section with headquarters at Hicksville, N. Y., and Nassau and Suffolk Counties to constitute the territory.

Paducah Section. Council authorized Section status for the Paducah Subsection of the Louisville Section; headquarters at Paducah, Ky., and these counties to constitute the territory: In Indiana, Knox, Daviess, Martin, Gibson, Pike, DuBois, Spencer, Posey, Vanderburg, and Warrick; in Kentucky, Union, Henderson, Daviess, Crittenden, Carlisle, Webster, McLean, Livingston, Lyon, Graves, Calloway, Caldwell, Hopkins, Muhlenberg, Fulton, Ballard, Hickman, Todd, McCracken, Marshall, Trigg, and Christian; in Missouri, Scott, Mississippi, Stoddard, New Madrid, Cape Girardeau, Pemiscot, and Dunklin; and in Illinois, Wabash, Edwards, Hamilton, White, Franklin, Jackson, Williamson, Saline, Union, Gallatin, Massac, Johnson, Pope, Hardin, Alexander, and Pulaski.

Idaho-Montana Section. In connection with the realignment of Regions, the Council at its meeting on Nov. 30, 1959, approved the formation of the Idaho-Montana Section subject to approval of the Inland Empire Section. R. B. Campbell, chairman of the Inland Empire Section, reports that on March 10, 1960, the Executive Committee of the Inland Empire Section unanimously approved the formation of the Idaho-Montana Section.

Engineers' Forum European Trip. The Engineers' Forum of the Metropolitan Section has planned a charter trip to Europe by air leaving July 2 and returning July 25.

Engineers Joint Council. Report. At the EJC Executive Committee meeting, March 18, 1960, V. W. Smith reported that G. E. Holbrook was elected Vice-President of EJC to fill the vacancy created by the resignation of Cecil Boling. Among the major items of business were the actions taken with respect to a Statement of Policy on Relationship Between Public and Private Engineering Services in Governmental Agencies; the Nuclear Congress—that the Congress should be held on alternate years in conjunction with an Exposition; also reported was the interest in both EJC and by the readers of MECHANICAL ENGINEERING with respect to the insert "Engineer" in the January issue of MECHANICAL ENGINEERING. For the present, however, EJC will continue to publish the "Engineer" as a separate publication. He also stated that a new EJC report, "Employer Practices and Expectations With Respect to Safe-

guarding of Proprietary Rights," is in the process of being published.

Engineers' Council for Professional Development. Report. W. H. Larkin reported that ECPD had now received a tax-exempt status under paragraph 501(c)3 of the Internal Revenue Code. He stated that a financial report prepared under his direction, as chairman of the Finance Committee, had been adopted by ECPD.

Conference of Engineering Societies of Western Europe and U. S. A. (EUSEC). The Council authorized the attendance of the Secretary at the Conference of Engineering Societies of Western Europe and U. S. A. (EUSEC) to be held in Brussels, Aug. 29–Sept. 3, 1960.

Certificates of Award. A certificate of award has been prepared for William H. Larkin, retiring chairman of the Engineers Registration Committee.

Retiring Section chairmen for whom certificates of award have been prepared include the following 1958–1959 Section chairmen: Robert C. Portouw, Oregon; Winston W. Gottschalk, Susquehanna; Victor J. Johnson, Rocky Mountain; Edward W. Jerger, St. Joseph Valley; and Alexander Hammer, Western Massachusetts.

The Council authorized the preparation of a certificate of award for W. R. Felts of the Columbia Basin Section for his outstanding service to the membership of that Section as a member of its Executive Committee.

Presidential Appointments. C. W. Crawford, March 26, 1960, College Station, Texas, Inauguration of President of Agricultural and Mechanical College of Texas.

E. G. Bailey, W. G. McLean, and W. E. Reaser, April 7, 1960, Lafayette College, Easton, Pa., funeral of Paul B. Eaton.

W. B. Pegram and T. W. Hopper, April 8–9, 1960, Philadelphia, Pa., 64th annual meeting of The American Academy of Political and Social Sciences.

G. H. Howell, April 25, 1960, Mount Pleasant, Mich., Inauguration of President of Central Michigan University.

W. C. Heath, April 25–29, 1960, Los Angeles, Calif., annual meeting and Welding Exposition of the American Welding Society.

H. D. Harkins and C. W. Wheatly, June 1–4, 1960, Vienna, Austria, 100th Anniversary of the Austrian Architects, Consulting and Civil Engineers.

Deceased Member. The Council noted with deep sympathy the death of Paul B. Eaton, professor-emeritus of mechanical engineering, Lafayette College, on Tuesday, April 5, 1960. Professor Eaton was Vice-President, 1947–1949, and Director, 1940–1942 and 1951–1953 of the Society.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
(Agency)

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 per cent of the first month's salary if a nonmember, or 50 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	29 East Madison St.	57 Post St.

The New York office of the Engineering Societies Personnel Service, Inc., will be open on Thursday evenings until 7:00 p.m. for interviews.

Men Available[1]

New York Office

Chief Engineer or Assistant; BSME; 47, medium or heavy machinery design; 22 years of designing, engineering, plant layout, supervision and administration, special semi and automatic machinery and equipment for the manufacture of tin plate, cellophane, chemicals, plastic, nylon, film, and precision parts. Also, design of laundry appliances and ship machinery and equipment. $13,000–$15,000. East, Midwest, or South. Me-825.

Technical Administrative R&D Engineer, Aircraft; 33; English apprenticeship training, degree and five years' design. Subsequent nine years' experience in Canada and U.S. in design, sales representation, technical evaluation, and project direction in aircraft and mechanical fields. Seeks administrative, sales, or engineering position in Europe. Available August. Me-826.

Chief Engineer; BSME, 13 years' experience in missile and aircraft field on small turbines, servos, ground support, and electromechanical products. Background of organizing, building up, and managing engineering, marketing, and production groups. $23,000. Location optional. Me-827.

Chief or Assistant Chief Engineer; BME, 20 years machine design, automatic machinery, machine tools, electric hydraulic controls; three years power transmission, clutches. PE Conn. and N. Y. $15,000 Location optional. Me-828.

Recent Graduate; BME, interested in heat-power engineering, design, development, etc. $6240. East. Me-829.

Application or Sales Engineer; BAeE, five years in metalworking and sheet-metal manufacturing fields, including production and layout. $5200. East. Me-830.

Chicago Office

General Manager; 56; 35 years' experience all phases design, sales, and management in field of bridge and gantry cranes, level luffing cranes, duty cycle-type grab bucket unloaders. Registered ME. West or Midwest. Me-1087-Chicago.

Design or Project Engineer; BSME, 36; nine years' experience in machine design with major machine-tool builder and manufacturing experience in production tooling and processing. Responsibility for development of full projects including planning, scheduling, designing, drafting, cost estimation, and liaison work with vendors, Available immediately. Midwest, Southwest, or West. Me-1094-Chicago.

Technical Management; BS, 44; 16 years of management experience, eight as director of research and development, eight as general manager with production responsibilities; specialist in getting new designs into service. Location optional. Me-1096-Chicago.

San Francisco Office

Designer; ME, 38; five years' design of missiles and instruments; manufacturer. Two years' design of heat, air-conditioning equipment for builders and engineers. $7200. Prefers San Francisco Bay area. Home: San Francisco. Se-1097.

Industrial Engineer; ME, 38; manager of industrial engineering for concerns engaged in fabricating products made up from castings, screw-machine parts, stampings, formings, weldments, and spinning. Responsible for production control, quality control and inspection, methods, cost analysis, plant layout, materials handling, tooling, and work flow. $11,000. Prefers Calif. Home: Calif. Se-848.

Design, Development, Application; ME, Agr, 31, EIT. One year process engineer, design conveyerized assembly line, methods, tool, quality and production, layout for electronic aircleaner manufacturer. One year lab technician, development and sales, test of chemical processing equipment. Salary open. Prefers West or Southwest. Home: Ind. Se-1689.

Designer, or Maintenance; ME, 24. One year design of electric wire routing, supports and insulation, and high-temperature furnaces for airplane and missiles manufacturer. Two years maintenance repair of all types of heavy equipment; also design and construction of specialized equipment. Experienced welder. $6600. Prefers Rocky Mountains, West Coast, or Foreign. Home: Wash. Se-549.

Project Engineer; ME, 43. Ten years charge of contacts, negotiate, design of heating, ventilating, and air conditioning; mechanical contractor and consultant. One year estimate heating and ventilating for contractor. Five years partner in stamping and machine shop, charge of sales, production control. $10,000. Prefers San Francisco. Home: San Francisco Bay area. Se-547.

Management Engineer; MSME, 43. Experienced in training of engineer and scientist supervisors in effective program administration; gift for organizational trouble-shooting. Proved project organizer and executive; successful assistant to director of research and development programs. Knows co-ordination of direct and support manpower, procurement, research and development contracts, test facilities, budgets, reporting, professional and scientific personnel. $15,000. Prefers Far West, San Francisco Bay area. Home: Calif. Se-431.

Designer; 54; 28 years' engineering practice in rolling mills and allied equipment for fabrication of aluminum and steel sheet and rod. Also new plant layout and facilities design. $9600. Prefers West. Home: Calif. Se-341.

[1] All men listed hold some form of ASME membership.

Production, Packaging-Handling Systems; ME; 39; 12 years design and application of material-handling equipment and systems with automation control. Supervision of major installations and sales proposal engineers. Customer contact experience. $9000. Prefers West Coast. Home: Calif. Se-1131.

Product Designer; ME, 32. Heavy experience in research and development and design of light components in various missile fuel systems and aircraft mechanisms backed up by practical field experience. Excellent record with people and problems solutions. $8400. Prefers West Coast. Home: Wash. Se-1130.

Mechanical Designer; ME, 56. Registered CE, Calif., 20 years' experience with oil companies. Four years steel, conveyers, heavy machinery; four years shipbuilding; two years food canning; four years architect and engineer and consulting civil engineer. $7200. Prefers San Francisco, Sacramento. Home: Calif. Se-1080.

Production Engineer; ME, 38. Ten years' experience on ordnance weapons; process, production, methods, time study, manufacturing. Two years design, jigs, dies, fixtures, for machine job shop. Two years production, estimates for telephone company. Two years design in steel foundry, blast furnaces. $15,000. Prefers West Coast. Home: West. Se-634.

Plant Superintendent; ME, 39; 16 years' experience in machine shop and assembly methods. Ten years plant manager, fully familiar with diesel engines, gas turbines, compressors. $10,000. Prefers Southern Calif. Home: N. Y. Se-923.

Plant Supervisor; ME, 41. Plant production manager, engineering supervision, production engineering; heavy in production planning, estimates, supervise, methods, cost reduction, fabrication, assistant in welding. Products: Tanks, hoppers, dump bodies, rock bodies, snow plows, road equipment, custom work. $10,000. Any location. Home: Calif. Se-746.

Field Engineer; ME, 33. Registered PE, Calif. and Ore. Nine years' experience in plant engineering, research and development, production. Presently plant engineer for large woodproducts company in charge of design and construction of buildings, conveyers, and special machinery. $8400 up. Prefers Overseas. Home: Calif. Se-639.

Plant Engineer; ME, 35. Professional ME License. One year design, selection of equipment, supervise drafting, specifications, inspect for public works. Six months machine design, warehouse refrigeration, site drainage, test and repair boilers; for food-packaging company. Three years operation of development lab on furnaces and air-conditioning equipment. Four years test on power-generating equipment and controls; for utility. Salary open. Any location. Home: San Francisco Bay area. Se-544.

Sales Engineer; ME, 31. Two years design of heating and ventilating systems for office and equipment buildings. One year sales and service on glass-fiber insulation. $5700. Prefers San Francisco Bay area. Home: San Francisco. Se-568.

Positions Available

New York Office

Chief Industrial Engineer; 35–40, engineering degree required, ten to 15 years' job-shop-type experience necessary. Thorough knowledge of methods, tooling, job evaluation, wage incentives, plant layout, machining, and heavy fabrication required. Must be an excellent administrator. Experience in concerns that produce large machinery on a job-shop or custom basis is desired. $12,000–$15,000; relocation expenses paid; fringe benefits. Western Pa. W-9000.

Project Engineers. (*a*) Project engineer, two to five years' experience in preparation of heating, ventilating, air conditioning, plumbing, and service-piping system drawings and specifications. Work will involve 50 per cent drawingboard layout, detail, and checking; 50 per cent calculations involving heat loss/heat gain for sizing heating, and air-conditioning units. To $8000. (*b*) Project engineer, about one year's experience in designing experimental equipment, modifying existing equipment to meet the needs of a specific project, design tools and fixtures related to metallurgical finishing and corrosion program. $7200, plus. Va. W-8993.

Industrial Engineer; graduate mechanical, knowledge of tool room or apprenticeship helpful. Minimum of five years in metal trades, electric motors, and/or small parts manufacture or similar field. Experience in setting standards, MTM, machine-shop background necessary. $6000–$8000, plus fringe benefits. Company will pay placement fee and moving expenses. Suburb of Boston, Mass. W-8983.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members; $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

Senior Industrial Engineer; degree desirable, three years' minimum in related experience, to be responsible for the general management of shop operations; scheduling, estimating, material control; recommend and specify the acquisition of standard and special machine and tool equipment; analyze operationally and estimate shop work. $7800–$10,000. N. J. Met. area. W-8977.

Superintendent, Toolroom for manufacturer of small sheet-metal parts, to take charge of toolroom involving full responsibility for building and maintaining all types of tools, dies, gages, special devices, etc. Plan and lay out work schedule in accordance with requirements. Salary open. Conn. W-8970.

Engineers. (*a*) Research and development project engineer, electrical or mechanical graduate, knowledge of the electronic problems in the data processing field and ability to carry future products from the design concept to prototype completion, logical circuitry, block diagrams: breadboard experience required. (*b*) Research and development project engineer, mechanical, knowledge of electromechanical problems involved in card and tape handling and allied problems of data processing. Ability to carry future products from the design concept to prototype requirements. $10,000–$12,000. Company pays placement fees. Conn. W-8969.

Senior Industrial Engineer; IE degree, minimum of three years' experience. Time and methods study, layout, cost analysis, and estimating. To $7800. Pocono Mountain area. W-8960.

Chief Industrial Engineer; graduate preferred, 28–35, experience in an industry which employs molding techniques, wire-extrusion processes, and/or wire-terminal work. Will be in charge of five to nine industrial engineers and supervise activities in preparation of estimates, preparation of manufacturing specifications, setting of standards, methodizing of process, and trouble-shooting on the production floor, covering electric blankets and various types of heating assemblies. $8000–$9600. Ky. W-8947.

Product Engineer for turbocompressor engineering group, graduate mechanical engineer, heavy emphasis on fluid mechanics, thermodynamics, mathematics, and strength of materials; graduate study preferred; at least five years' experience in the field of machine design. Will work with product engineers on specifically assigned studies that would involve product application, product design, product research, and standardization on turbocompressors. $8500–$10,000, depending upon experience. N. J. W-8941.

Methods Engineer to take charge of methods and setting of standards on machine-tool operations. Must be thoroughly trained in rate-setting methods and familiar with operation of general purpose machine tools such as engine lathes, turret lathes, milling machines, shapers, planners, horizontal and vertical boring mills, cylindrical and surface grinders, etc. Opportunity for advancement. Conn. W-8940.

Production Engineer; mechanical graduate, tooling, methods, and assembly experience of small mechanical and electromechanical devices covering cameras, projectors, or allied equipment, $12,000–$15,000. Westchester County, N.Y. W-8939.

Sales Engineer; graduate mechanical or electrical, minimum of two years' experience in the sale of electrical indicating instruments, electromechanical controls, and precision components, to be responsible for sale of electrical indicating and controlling instruments and precision components to equipment manufacturers within a specific sales area. Generally local travel. Substantial salary plus commission and bonus. Headquarters, Newark, N. J. area. W-8936.

Industrial Engineer; degree and minimum of five to ten years' working experience, preferably in both line and staff, to serve with a small group assisting and co-ordinating industrial-engineering activities of 20 small plants of multiplant company. Should have ability to assist plant managers and industrial engineers in planning and carrying out projects on cost reduction, methods, work simplification, material handling, layout, production control, job evaluation, manning requirements, work measurement, wage incentives, and long-range planning in mechanical, electrical, and refractor fields. $9000–$10,000. Upstate N. Y. W-8922.

Manager, Promotional Sales; college graduate, military liaison experience. In addition, must have some promotional sales background in order to develop a promotional plan for advanced planning. Should have an understanding of sales aids, brochures, exhibits, professional meetings, etc. $20,000. East. W-8916(*b*).

Manager, Reliability and Quality; thorough understanding of reliability, quality assurance, and safety. Capable of establishing philosophies, goals, and attendant functions for proposals on new programs. $20,000. East. W-8915(*a*).

Machine-Design Engineers; at least five years' experience in basic design of machine elements that include highly precisioned gearboxes, drives, mechanical controls, interlocking devices, etc. Must have thorough knowledge of machine-shop and weld-shop procedures, including tolerances and strength of materials. Must be able to work with government specifications. $8000–$12,000, to start. Northern N. J. W-8910.

Methods and Tool Design Engineer; graduate mechanical, minimum of five years' experience in tool design; knowledge of various metals used in the manufacture of tools is mandatory. Must have capability in tooling required for pressing, fabricating, welding, and machining. Must be capable of selecting suitable materials and check supplemental designs prepared by others, analyzing final designs as to construction cost, safety, weldment, casting, and durability of materials. Apply by letter, including salary requirements. Upstate N. Y. W-8908.

Mechanical Engineer, X-Ray Instrumentation; to work with physicists on design and development of research instrumentation. Require man with at least five years' experience in designing fine precision instruments, preferably, but not necessarily, on x-ray equipment. Experience in optics and electromechanical devices helpful but not required. Open, Westchester County, N. Y. W-8900.

Chicago Office

Senior Project Engineer; graduate engineer 30-45, at least ten years' experience in design and development work ranging from special machinery to consumer goods. Will do product and special machine design, practically all development. Must be willing to make own layouts and supervise the making of details by draftsmen. Will be expected to carry own projects with a reasonable amount of help and supervision. Company does project and process development for industry and military. Must be U. S. citizen. Open depending upon experience. Ohio. C-8080.

Project Engineer; graduate mechanical, to 40, at least ten years' experience in design and development, to design and develop mechanical, hydraulic, and pneumatic instruments, and packaging machinery. Unusually good potential. $10,000–$12,000. Employer will pay fee. Northwest Chicago suburb. C-8078.

Development Engineer; mechanical graduate, to 32; will consider a recent graduate to a man with ten years' experience in research and development. Will do research and development in the design of instruments, weighing devices, controls, and servomechanisms. Travel, no car required, for a scale manufacturer. To $9600. Employer will pay fee. Ohio. C-8067(*a*).

Standards or Specification Engineer; graduate mechanical or electrical, to 40, experienced in development and promotion of standardization of parts, processes, and materials. Will work in staff section of large multiplant manufacturer of industrial and electrical equipment. To $10,000. Southern Wis. C-8050.

Sales Engineer; engineering degree, at least two years' experience in operation or design of water and waste-treatment equipment; knowledge of

water treating, or Ion exchange, or inorganic waste-treatment equipment. Will engineer a treatment system, based upon customer's inquiry, using standard equipment, write sales letter to customer with quotation on equipment, etc. $9000–$10,000. Employer will negotiate fee. Southwest Chicago suburb. C-8045.

San Francisco Office

Designer; ME, at least four years' experience machine design and process development of production machinery, jigs, equipment, and mechanisms; to redesign for modification, rebuilding, or adapting new or installed continuous production equipment for new or varied purposes, or light steel or aluminum metalworking. $7200–$8400. San Francisco East Bay. Sj-5254.

Junior Plant Engineer; preferably ME graduate under 30, one to two years' experience. Will train in foundry, machine shop, production, plant maintenance, new additions relating to diesel engine manufacture and iron and steel foundry. For plant engineering office. $6000. San Francisco East Bay. Sj-5253.

Mechanical, Civil, or Mining Engineer; minimum three years' experience, preferably more, in design, computation, and layouts on structural steel and heavy equipment used in open pit and underground mining and milling plants. Must be familiar with typical mine and mill plant-engineering-type operation and able to furnish sound advice and recommendation on structural elements for installing new equipment and revamping existing plant. $7200–$7800. Idaho. Sj-5246.

Sales Engineer; mechanical background, 24–38. Aptitude for or experience in sales engineering on products to o.e.m.'s in Western States and ability to work with distributors. Should be able to read blueprints, perform elementary math calculations, have some knowledge of design and strength of materials relating to rotating machinery, parts, and components. One required in San Francisco, one for Los Angeles. For a manufacturer's district office. $5200–$7200; with merit increases. Car furnished. Sj-5244.

Fire-Protection Engineer; engineering degree, recent graduate to five years' experience, to train for and participate in survey, evaluation, and report covering fire-fighting facilities, structural conditions, and conflagration hazards; work involves close contact and co-operation with municipal officials in Western cities. Desire men with good appearance, ability to speak and get along well with persons in responsible positions, and with high integrity to develop these parts in grading cities and towns of 25,000 and over. Will also include elements of reliability and adequacy of water supply, fire department, fire-alarm systems, and other features. Cover eight Western states. U. S. citizens. Salary commensurate. Headquarters, San Francisco. Sj-5242.

Trainee Estimator; ME, recent graduate to two years' working experience with interest and aptitude in training for take-off and estimating heavy piping, fans, pumps, blowers, etc., for heavy equipment installation. For an engineering builder. Salary competitive. San Francisco. Sj-5237.

Field Engineer; ME, minimum five years' experience, preferably more, in heavy pipe detailing and layout and knowledge of pumps, fans, blowers, and other equipment encountered in hydraulic powerhouse. Should be able to make field changes and designs, expedite materials, work up bills and materials, assist superintendent, keep track of progress. Salary commensurate with experience. For an engineering builder. S. D. Sj-5236.

Sales Engineers; mechanical or chemical-engineering training, preferably under 35. Knowledge of hydraulics, piping, and with sales and in-plant experience (familiar with plant machinery and equipment). To sell water-treating equipment and softeners to mechanical contractors and large industrial users (pressure filters, water softeners, associated components). About $6600, plus 2 per cent commission on sales over $150,000, plus expenses. One for San Francisco Bay area; one for Los Angeles (must know Los Angeles area). Sj-5225.

Sales, Estimate; experienced man to take-off and estimate on electrical equipment such as cable trays, power struts, and possibly metal partitioning for industrial, commercial, and general use. Able to deal with engineers, architects, and owners and to assist in preparation of specifications and developing layouts for clients. Potential to $10,000 in developed territory. For a manufacturer's agent. San Francisco area Sj-5211.

Designer; ME or equivalent, for design and development of gas-fired heating; minimum two

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NATURE OF WORK DONE

NAME OF EMPLOYER (Give name in full)

Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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- ☐ MECHANICAL ENGINEERING — 10th of preceding month
- ☐ *Journal of Engineering for Power*
- ☐ *Journal of Engineering for Industry*
- ☐ *Journal of Heat Transfer* — 20th of preceding month
- ☐ *Journal of Basic Engineering*
- ☐ *Journal of Applied Mechanics*
- ☐ *Applied Mechanics Reviews* — 1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

- ☐ A—Aviation
- ☐ B—Applied Mechanics
- ☐ C—Management
- ☐ D—Materials Handling
- ☐ E—Oil and Gas Power
- ☐ F—Fuels
- ☐ G—Safety
- ☐ H—Hydraulics
- ☐ I—Human Factors Group
- ☐ J—Metals Engineering
- ☐ K—Heat Transfer
- ☐ L—Process Industries
- ☐ M—Production Engineering
- ☐ N—Machine Design
- ☐ O—Lubrication
- ☐ P—Petroleum
- ☐ Q—Nuclear Engineering
- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

to three years' working experience with complete heat design including AGA and knowledge of production methods. Will work as project engineer if qualified. Northern San Francisco Bay area. Salary commensurate with experience. Employer will negotiate fee. Sj-5201.

Sales Engineer; engineering background and knowledge of equipment sales (preferred in packaging field). Contact clients concerning cannery warehouse and food-industry overwrapping and code marking and imprinting equipment. Work in developed territories quoting on needs for such equipment and prepare specifications, supervise installations and start-up. Five per cent sales and five per cent installation basic commission setup, $150,000 gross potential. One for Southern Calif. and Ariz.; one for San Francisco Bay area. For manufacturer's representative. Sj-5194.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after June 24, 1960, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

DUVES, GERRIT, Florence
FERRANTI, ANGELO L., Huntsville

Arizona

YISSAR, LEVI, Tucson

Arkansas

MCCALEB, JOHN H., Little Rock

California

BALDELLI, HUGO, Los Angeles
BATES, HOWARD J., Torrance
CAMPO, JULIO H., Canoga Park
INMAN, ROBERT M., Los Angeles
LELAND, JAMES M., Pomona
LJUBICIC, MILADIN, Monterey Park
MCCLUNE, CHARLES V., San Mateo
MEIROVITCH, LEONARD, Los Angeles
PEINADO, CHARLES O., Canoga Park
RAABE, ERNST, Long Beach
•ROESCH, ERNST, Lodi
STEWART, HENRY L., Monterey Park
STILTNER, MARSHALL A., Orinda
SUMMERS, ROBERT C., Culver City
WALKER, RAYMOND W., Huntington Beach

Colorado

EWALD, CLARK B., Westminster
JOHNSON, HERBERT E., 3RD, Boulder
WANGELIN, HUGO, Littleton

Connecticut

BAKER, MORTON H., Danbury
BAXTER, HOWARD S., Greenwich
•BOWEN, ALBERT E., JR., Old Greenwich
CLOUGH, WILLIAM R., Middletown
MCGRATTAN, ROBERT J., Groton
SEVITZ, JAMES A., JR., Milford
WEISZ, WILLIAM, Fairfield

District of Columbia

MILLS, ROBERT G., Washington
MOORE, ROBERT E., Washington

Florida

KEAR, GEORGE H., St. Petersburg
MOORE, CARL B., Miami
REINSCH, ROBERT T., Lakeland
WILLIAMSON, EUGENE P., Pensacola

Illinois

ADAM, JAMES C., Rockton
CAITUNG, SEVERIN, Glencoe
DE, CHANDRA N., Harvey
EVANS, LAWTON P., Peoria
LOTTES, PAUL A., Park Forest
•MENKEN, ROBERT C., Bradley
MYKKANEN, DONALD L., Urbana
WHITAKER, ROBERT L., Oregon

Indiana

CHADDOCK, JACK B., Lafayette
MCLEAN, ARTHUR F., South Bend

Iowa

RUDIG, DEAN E., Waterloo
•SWENSON, VICTOR E., Cedar Falls

Massachusetts

•ARIEWITZ, DANIEL, Framingham
BOISSEVAIN, THOMAS A., Boston
•WEISBERG, NORMAN, Framingham

•Transfer to Member or Affiliate.

Michigan

BOETTGER, HAROLD E., Detroit
BRENKERT, KARL, JR., East Lansing
CHRISTENSEN, DONALD F., Jackson
•DONOVAN, JOHN F., JR., Birmingham
DONOVAN, JOHN T., Midland
•GOODMAN, LEONARD J., Detroit
•HOLMES, ARTHUR D., Mt. Clemens
•JENNINGS, WALTER E., Midland
KERR, ROBERT R., Jackson
LEWIS, THOMAS A., Detroit
OGAWA, PAUL K., Saginaw
SHIRE, PHILLIP R., Jackson
TROY, CARL W., Jackson

Minnesota

BERKHOLTZ, NICHOLAS E., Minneapolis
JOHNSON, ROBERT C., Minneapolis

Missouri

RABIUS, JOHN H., Kansas City

Nevada

MCKEE, ROBERT B., JR., Reno

New Jersey

AUCOCK, JOHN P., North Bergen
BECKSTEIN, ERICK J., East Orange
BITTEL, LESTER R., Riverdale
BUTLER, THADDEUS R., Ridgewood
MOTTEL, SAMUEL, Paramus
POLLARD, RICHARD J., Bergenfield
RHODES, RICHARD, Plainfield
SAVINELLI, EMILIO A., Boonton
SHEETZ, HARRY J., 3RD, Camden
•SILVERMAN, MELVIN, Fords
STANGE, JOHN R., Rochelle Park
ZANONI, PAUL J., Scotch Plains

New Mexico

TREAT, CHARLES H., Albuquerque

New York

BALDINI, ROBERT M., Forest Hills
BLOSS, HAROLD E., Wellsville
BURTON, DENNIS H., Allegany
•CHRISTENSEN, JOHN G., Crestwood
COTTER, JAMES F., Glen Head
EDWARDS, ROY R., New York
•ELLISON, WILLIAM, New York
FAY, THOMAS B., New York
HASSMAN, MARVIN, Brooklyn
HENRY, ROBERT E., Central Islip
•KING, FREDDIE C., Schenectady
KLEIN, FREDERIC W., Glen Cove
KOPP, ROBERT F., New York
LISEVICK, FRANK C., New York
•LOUNDON, DAVID A., New York
MELZER, JULIUS F., Portchester
MINNITI, NICHOLAS, Brooklyn
•MUENGER, JAMES R., Beacon
•NEWMAN, BERNARD, Jericho
•NOLAN, JOHN B., Schenectady
PAI, ROBERT H. C., New York
PARTINGTON, DERRICK, New Rochelle
RICH, DONALD G., Syracuse
•RUBIO, ABDON, Schenectady
SCHULTZ, DONALD E., Williamsville
SCHWARZ, KARL E., Corning
•SHEN, CHI-NENG, Troy

North Carolina

PIERSON, FRANK O., Charlotte

Ohio

BROWN, HAROLD R., Cleveland
CAMPBELL, KENNETH A., Cincinnati
CASNER, JOHN A., Youngstown
•COONEY, THOMAS R., Dayton
CURTIS, HAYNES E., Cincinnati
•DAVIES, JAMES E., Barberton
DIEHL, JOHN H., Bellefontaine
KRAVEC, JOHN A., Cincinnati
•ROEDER, JAMES W., Mount Vernon
WALSH, EDWARD J., Cleveland

Pennsylvania

DONLEY, JOSEPH L., Pittsburgh
•FLEMING, ROBERT W., Pittsburgh
•GADDIS, PAUL O., Pittsburgh
GOTTLIEB, MANIOUS, Drexel Hill
HESS, EDWARD K., Shillington
KAPIC, DAVORIN, Jeannette
LINDAHL, EDWIN E., Pittsburgh
RAO, MADIREDDI S., Pittsburgh
•REIER, JOHN C., York
YANEK, EDWARD J., York

Rhode Island

DVORAK, DENNY Z., Providence

Tennessee

•PREUSS, HOWARD M., Knoxville
REYNOLDS, WILSON T., Nashville
SZPARA, WALTER, Chattanooga

Texas

CLARK, ROGER S., Dallas
ETHEREDGE, KENNETH W., Groves
FELLRATH, ARCHIE R., Kerens
•FORMAN, HOWELL N., JR., Dallas
GRAVES, SHELBY J., Dallas
HUEY, HELMS R., Beaumont
LIPPMAN, GLENN E., Baytown
PARK, TRACY S., Houston
POWERS, LOUIS J., Lubbock
•SCHEINEMAN, JOHN A., Houston
SCHORRE, CHARLES E., Houston
•STORK, RICHARD H., Port Neches
WEEDEN, FRANK G., JR., Houston

Utah

BACHMAN, ROGER O., Salt Lake City
TURLEY, RICHARD E., Salt Lake City
WATKINS, REYNOLD K., Logan

Virginia

CASIMIRO, ANTHONY, Arlington
FREYLER, JOHN W., Springfield

Washington

GRAVES, JAMES L., Bellevue
HYLBAK, HARLEY E., Richland

West Virginia

BRYANT, DONALD D., Huntington
HENNESSEE, EUGENE L., JR., Parkersburg

Foreign

BELLI, CHARLES, Valletta, Malta
BROUGHTON, FREDERICK W., Toronto, Ont., Canada
BURGESS, EDWARD A., Montreal, P. Q., Canada
DOWD, DONALD P., Toronto, Ont., Canada
GILLEY, SAMUEL A. S., Surbiton, Surrey, England
JOSHI, GOPAL G., Deep River, Ont., Canada
KLEES, PIERRE, Bruxelles, Belgium
MACKENZIE-GRAHAM, ARTHUR, Aruba, Netherland Antilles
MIRZA, MUZAFFAR A., Karachi, West Pakistan
•RICE, MURRAY B., Hamilton, Ont., Canada
RIGA, GERALD J., Maracaibo, Venezuela
TEES, DAVID A., Buckinghamshire, England

OBITUARIES

Joseph Sena Rodrique Almeida (1915–1960), project control specialist, died, Ludlow, Mass., Feb. 22, 1960. Born, Guarda, Portugal, Aug. 6, 1915. Parents, Manuel and Clemintina (Sena) Almeida. Education, attended Quimbra Univ., Portugal, 1933; BS, Northeastern Univ. 1935; MS, Harvard Univ. School of Business Administration, 1936. Married Florence Trombley, 1942; child, Roderick Richard. From 1936 to 1950 Mr. Almeida was employed by Westinghouse Electric Corp. Since then he was with the Springfield Armory serving as Armory key inspector on a National Procurement Integrating Committee on assigned items contributing to formulation and development of nationwide inspection operations by evaluation of guides, procedures, and standards for development and application of inspection criteria. Later as ordnance engineer he co-ordinated preparation of cost estimates and schedules, and developed Armory proposals including manufacturing, engineering, research, and development work. Mem. ASME, 1959. He is survived by his widow and son.

Edwin Harrison Brown (1885–1960), consulting engineer, died, Milwaukee, Wis., Feb. 26, 1960. Born, Leavenworth, Kan., Feb. 3, 1885. Parents, Francis and Rheasa (Wilkins) Brown. Education, attended Kansas State College, 1901–1903; studied mechanical engineering at the Univ. of Nebraska until 1906. Married Dora Faris, 1913.

Mr. Brown spent much of his career with Allis-Chalmers Manufacturing Co., Milwaukee, Wis., in charge of the steam-turbine department. He became vice-president in charge of engineering development in 1942. Mem. ASME, 1943. He was awarded an honorary DE degree, Univ. of Nebraska, 1945. He is survived by his widow and two daughters, Mrs. H. E. Miner, Wheaton, Md., and Mrs. W. G. Jones, Fulton, Ill.

Morris Llewellyn Cooke (1872–1960), consulting engineer, Philadelphia, Pa., died March 5, 1960. Born, Carlisle, Pa., May 11, 1872. Parents, William Harvey (M.D.) and Elizabeth Richmond (Marsden) Cooke. Education, ME, Lehigh Univ., 1895; SD, 1922. Married Eleanor Bushnell Davis, 1900. Mr. Cooke became the first administrator of the Rural Electrification Administration by presidential appointment of Franklin D. Roosevelt in 1935. Previously he had served under Mr. Roosevelt when he was Governor of New York as member of the New York State Power Authority for the hydroelectric development of the St. Lawrence River. In his early career, Mr. Cooke was a reporter for *The Philadelphia Press* and *The Denver News*. Later he was financial editor of the *New York Evening Telegram*. From 1895 to 1896 he served an apprenticeship at Cramp's Shipyard, Philadelphia; was a journeyman machinist at Southwark Foundry; engineer for Acetylene Co., Washington, D. C., 1896–1897; and served as an engineering officer during the Spanish-American War. From 1911 to 1915 he was director of Public Works in Philadelphia. Under Governor Gifford Pinchot of Pennsylvania he served, in 1923, as director of the Giant Power Survey Board. He was chairman of the Mississippi Valley Committee of Public Works Administration, 1933; director of Water Resources Section of Natural Resources Board, 1934; and chairman of Great Plains Commission, 1936–1937. Mr. Cooke was frequently an arbitrator in labor disputes and with Philip Murray, then vice-president of CIO, wrote a book called "Organized Labor and Production." In 1942 he was named the United States Expert for adjudication of the dispute over oil properties between this country and Mexico; and later headed an American Technical Mission to Brazil. In 1949 he was honored by the Mexican government with the Order of the Aztec Eagle. Mr. Cooke served as member of President Harry Truman's Committee to Survey the Patent System and was appointed by him as chairman of a water resources policy commission. Assoc. Mem. ASME, 1903; Mem. ASME, 1909; Fellow ASME, 1936. He was a Manager of ASME in 1914–1915. He was the author of many pamphlets and articles advocating social-mindedness and social activation on the part of the engineering profession. He was a fellow of AAAS; member of the Society for Promotion of Engineering Education; Taylor Society, of which he was president in 1927; The Franklin Institute; Delta Phi; and Sigma Xi. He was honorary member of Masaryk Academy, Prague, Czechoslovakia, and received the Czechoslovak Order of the White Lion. He also was a recipient of the French Legion of Honor. Surviving are two sisters, Mrs. Irving W. Bonbright, and Mrs. Orlando N. Willcox, both of Englewood, N. J.

Ralph Copp (1884–1958), consulting mechanical engineer and industrial plant specialist, Webster Groves, Mo., died Nov. 3, 1958. Born, Waterloo, Ill., March 2, 1884. Parents, William Herbert and Mary Louise (Gilmore) Copp. Education, high-school graduate; studied refrigerating and steam and electrical engineering through International Correspondence School. Married Anna Dorothea Moser, 1925. Mr. Copp spent 25 years as supervising engineer for Pevely Dairy Co., St. Louis, Mo.; three years, during World War II, as chief consulting engineer for the Milk Division of the U. S. Department of Agriculture; and six months in Europe as senior consulting engineer for the Milk Conservation Program of the United Nations. He also was consulting engineer for the Materials and Facilities Division of the U. S. Department of Agriculture, and for ten years was chief engineer of the Meyer Blanke Co., St. Louis, Mo. He obtained patents on piston rings, filters, fluidtight joints, pasteurizing processes and equipment. For three years he was instructor of the advance class in refrigeration at the David Rankin School of Mechanical Trades in St. Louis. Mem. ASME, 1926. Member, also, National Society of Professional Engineers, Missouri Society of Professional Engineers, American Society of Refrigerating Engineers, National Association of Power Engineers. He was past-president of the Plant and Engineering Section of Dairy Industry Foundation of the U. S. He was a registered professional engineer in the States of Missouri and Iowa. Besides his widow, he is survived by a son, Dr. Ralph Copp, Jr., and a daughter, Mrs. Dorothea (Henry) Hoener, all of Webster Groves, Mo.

Mortimer Levering Diver (1887–1959), consulting engineer, San Antonio, Texas, died Nov. 28, 1959. Born, Lafayette, Ind., Dec. 2, 1887. Education, BS(ME), Purdue Univ., 1909. Mr. Diver was a specialist in structural engineering, power development, and legal reports. His early career included experience with the Indiana Lighting Co.; American Blower Co.; Clarage Foundry and Manufacturing Co.; H. A. Young, Chicago, Ill., designing water works; Stahl, Kinzie, & Chapman, Detroit, Mich., designing heating and ventilating equipment; and the Trussed Concrete Steel Co. In his private practice he designed and supervised building of bridges, buildings, dams, sewage disposal works, irrigation works, and heating and ventilating systems. Seven months of this time was spent in the construction division of the U. S. Army. Mem. ASME, 1922. Member also of ASCE, AAE, American Concrete Institute, American Association of Military Engineers, and Tau Beta Pi.

William Leonard Hunt Doyle (1891–1960), assistant professor, Bradley Univ., died in Peoria, Ill., Jan. 22, 1960. Born, Buffalo, N. Y., Jan. 12, 1891. Parents, William Leonard and Wilmina (Hunt) Doyle. Education, ME, Columbia Univ., 1914. Married, 1920; son, William B. During Mr. Doyle's professional career, he made significant contributions in the field of diesel-engine manufacturing and research with four firms, each a pioneer in the field of prime-mover application. His career began with De LaVergne Machine Co., N. Y. With Ingersoll-Rand Co., he was part of the team which innovated engines supplied with air from belt-driven, positive-pressure superchargers. As chief engineer of Baldwin-Southwark Corp., he was the leader in the development of locomotive diesel engines with a turbosupercharger resulting in a line of engines with performance equal to present-day experience operating at 120 psi bmep. With Caterpillar Tractor Co., he was in charge of development of Caterpillar supercharged engine with the positive-pressure, Roots-type blower. In the fields of Standards and Codes he was an active participant in the publication of three codes: "Power Test Code for Internal-Combustion Engines," "Power Test Code for Speed-Governing Systems for Steam Turbine-Generator Units," and "Recommended Specifications for the Speed Governing of Internal Combustion Engine-Generator Units." He was the author of papers on diesel engines and fuels. He holds four patents assigned to the Baldwin-Southwark Corp. and Caterpillar Tractor Co. Assoc.-Mem. ASME, 1916; Mem. ASME, 1940; Fellow ASME, 1956. Membership activities in ASME include: member and chairman, Oil and Gas Power Division Executive Committee; member and chairman, Professional Divisions Committee; chairman, Joint AIEE-ASME subcommittee; member and secretary, Power Test Code subcommittee (PTC No 17). Mr. Doyle was a registered engineer in the States of New York and Illinois. Member also, SAE, ASM, and ASTM.

William Henry Engelman (1883–1960), designer, Mechanical Div., of H. K. Ferguson Co., Cleveland, Ohio, died March 12, 1960. Born, Oldenburg, Germany, March 31, 1883. Son of Mr. and Mrs. John Henry Engelmann. Education, ME, Polytechnikum, Bremen, 1910. Naturalized U. S. citizen, Cleveland, Ohio, 1921. Married Adeline Sokolski; children, Carl Paul and Helmuth William. Mr. Engelman had a varied career in engineering. He was a draftsman on general construction, ore reduction, power plants, and furnaces; a designer of bottle-cleaning machinery, pasteurizers, and centrifugal pumps; and a designer of power plants and paper mills. With the Water Works, Cleveland, Ohio, for many years, he had charge of designing, testing, and supervising pumping stations. Assoc-Mem. ASME, 1927; Mem. ASME, 1935.

Gerald Gearon (1891–1960), chief inspector, Boiler and Refrigeration Department, of the City of Chicago, Ill., died Evanston, Ill., Jan. 20, 1960. Born, Greeley Centre, Neb., Dec. 29, 1891. Parents, Michael Bernard and Ambrosia (Garvin) Gearon. Education, graduate, Loyola Law School. Married Margret Snyder, 1911. Mr. Gearon spent his entire career with the City of Chicago; first, as assistant to supervising mechanical engineer, Department for the Inspection of Steam Boilers and Cooling Plants, and then as supervising mechanical engineer of this department. He was granted a professional engineer's license in 1945. Mem. ASME, 1927. Member, also, Board of Examiners of Stationary Engineers of Chicago, American Society of Refrigeration Engineers, The Chief Engineers Association of Chicago, and charter member of The National Board of Boiler and Pressure Vessel Inspectors. His wife survives him.

Samuel Robert Gerber (1888–1960), president, Ortho Chemical Corp., Long Island City, N. Y., died March 11, 1960. Born, New Haven, Conn., Oct. 5, 1888. Education, attended Polytechnic Institute of Brooklyn; BS, Cooper Union, 1911. Specializing in industrial engineering, Mr. Gerber was employed by Western Electric Co., N. Y.; Remington Typewriter Co., Ilion, N. Y., and De Laval Separator Co., Poughkeepsie, N. Y. In 1919 he became president of S. R. Gerber Co., New York, N. Y. and vice-president and general manager of Caravel Machine & Tool Works, Brooklyn, N. Y. Jun. ASME, 1913; Mem. ASME, 1941.

Robinson Cox Glazebrook (1907–1959), chief sales engineer, Pump Div., Fairbanks, Morse & Co., Beloit, Wis., died April 23, 1959. Born, Washington, D. C., July 13, 1907. Parents, Larkin White and Jane (Threlkeld) Glazebrook. Education, ME, Cornell Univ., 1929. Married Florence Rowene Hunt, 1936; child, Virginia Robinson. Mr. Glazebrook began his career with E. I. du Pont de Nemours & Co., Inc., Buffalo, N. Y. In 1930 he joined Fairbanks, Morse & Co., where he was engaged in production engineering; later a hydraulic engineer. He also worked in development and research for the company until, in 1939, he was made engineer in charge of the Hydraulic Div. Jun. ASME, 1932; Mem. ASME, 1940.

Gilbert Howe Gleason (1881–1959), retired, partner, G. H. Gleason & Co., died, Winter Park, Fla., Oct 27, 1959. Born, Boston, Mass., July 20, 1881. Parents, William Henry and Ella (Aldrich) Gleason. Education, attended M.I.T. Married Celia M. Baker, 1903. Mr. Gleason became vice-president of Dexter Engineering Co., Providence, R. I., in 1911, in charge of design and installation of heating and drying systems. He was later a partner in Gilbert Howe Gleason & Co., sales agents, Boston, Mass. Jun. ASME, 1906; Mem. ASME, 1912. Surviving are his widow; a daughter, Mrs. Audrey Gleason, Summit, N. J.; and two sons, Gilbert Howe Gleason, 3rd, Oberlin, Ohio; and Anthony Howe Gleason, Summit, N. J.

John Dudley Hackstaff (1877–1960), consulting engineer, died, Los Angeles, Calif., Feb. 2, 1960. Born, St. Louis, Mo., Oct. 26, 1877. Parents, J. Frank and Priscilla (Dudley) Hackstaff. Education, ME, Stevens Institute of Technology, 1898. Married Kate Florence Baker, 1908. Mr. Hackstaff's specialty was in design and construction of natural gas and oil distribution, transporation systems, and pipeline work. He was in charge of construction at the Hope Engineering & Supply Co., Pittsburgh, Pa., 1907–1911; in charge of gas and pipeline work for the J. G. White & Co., 1911–1913; general manager of Southern California Gas Co., 1913–1915; with Empire Pipe Line Co., 1916–1920; in charge of operation of Emerald Oil Co., 1920–1921. Since 1920 he was engaged in consulting practice in Los Angeles, specializing in Patent Causes and Utility Regulation. From 1928 to 1932 he was consulting engineer for the City of Buffalo, N. Y., and was chief inspector for the Susquehanna Pipeline Co., 1931–1932. Jun. ASME, 1901; Mem. ASME, 1917. Mr. Hackstaff received an ASME 50-year pin. He was a member of the Pacific Coast Gas Association and the Natural Gas Association of America. He is survived by his widow and a daughter, Katherine H. (Mrs. J. V.) Schlegel.

William Edward Hamilton (1884–1960), retired consulting engineer, partner, Sanderson & Porter, New York, N. Y., died Feb. 18, 1960. Born, Pottsville, Pa., Dec. 9, 1884. Parents, William Thomas and Katharine Louisa (Bell) Hamilton. Education, CE, Rensselaer Polytechnic Institute, 1910. Married Virginia May Fey, 1913. Mr. Hamilton's specialty was construction and preliminary operation of steam-power stations. As assistant resident engineer, Alabama Power Co., Birmingham, Ala., 1912–1914, he was in charge of all field engineering during construction of the 70,000-hp hydroelectric development of Lock No. 12 on the Coosa River, Ala. With Sanderson & Porter he was superintendent of construction on a 30,000-hp hydroelectric plant, Cohoes, N. Y., and on a 10,000-hp steam-power station at Parkersburg, W. Va., 1914–1916. In 1916 he supervised construction of an addition to the Coosa River plant. In 1917 he was works manager for Anniston Steel Co., Anniston, Ala. From 1917 to 1923 he was resident engineer and construction superintendent for Sanderson & Porter in charge of field design, construction, and operation of several steam-power stations. In 1923 he became manager of construction of steam-power plants, transmission lines, and substations. He was a partner, Sanderson & Porter, 1942–1955. Mem. ASME, 1924. He was a life member of ASCE. Member, also, Army Ordnance Association, Rensselaer Society of Engineers, Tau Beta Pi, and Beta Delta Beta.

Robert Leon Hulsizer (1896–1960), supervising engineer, New York and Pennsylvania Co., Inc., Lock Haven, Pa., died Jan. 27, 1960. Born, Milton, Pa., Dec. 7, 1896. Parents, John J. and Rose (Montgomery) Hulsizer. Education, attended U. S. Navy Steam Engineering School, 1918; BS(ME) Bucknell Univ., 1921. Married Laura C. Reigle, 1922; children, Lauretta and Joan M. Mr. Hulsizer spent many years with various electric and power companies. From 1932 he was steam and power engineer with New York and Pennsylvania Co., Inc., and Castanea Paper Co., in charge of design, construction, and operation of all steam and power plants. Student Mem. ASME, 1919; Jun. ASME, 1921; Mem. ASME, 1937. Chairman, Central Pennsylvania Section, ASME, 1945–1946; member, Executive Committee, 1943–1947. Citation from War Production Board, 1945.

William Charles Krautheim (1898–1960?), chief mechanical engineer, General Steel Castings Corp., Granite City, Ill., died recently according to report received by the Society. Born, Granite City, Ill., April 8, 1898. Parents, Fred W. and Anna (Thumser) Krautheim. Education, BS,

Univ. of Illinois, 1923. Married Irma A. Tebben; two children, Mrs. R. J. Mellis and William Charles, Jr. Specializing in the design of railway steel castings, Mr. Krautheim received several patents pertaining to his railway devices. He was an estimator and calculator with the Commonwealth Steel Co., Granite City, Ill., 1917–1930, and joined General Steel Castings Corp. in 1930. Jun. ASME, 1921; Mem. ASME, 1942. He was Vice-Chairman of the St. Louis Section, ASME, in the 1930's.

Darrell William Morgeson (1907–1960?), industrial engineer, Guided Missile Division, American Bosch Arma Corp., died recently according to notice received by the Society. Born, Louisville, Ky., Nov. 25, 1907. Education, attended Notre Dame Univ.; served apprenticeship in tool and diemaking and designing, Sprague Sells Corp., Hoopeston, Ill.; and attended General Motors Institute of Technology for special study in production and tool engineering. Married; three dependents. Mr. Morgeson was with Bendix Aviation Corp., South Bend, Ind., and Wayne, Mich., from 1928 to 1941, serving as tool engineer, supervisor of education, industrial engineer in the Aircraft Div., superintendent of the Landing Gear Div., and resident engineer. He was later tool engineer and consultant, Lee Engineering Co., Inc., Detroit, Mich.; with Adel Precision Products Corp., Burbank, Calif.; Packard Motor Car Co., Toledo, Ohio; Owens Illinois Glass Co., Kimble Div., Toledo, Ohio; and staff engineer, Weapons Div., at the Univ. of California, Los Alamos, N. Mex. Mr. Morgeson was editor of the Bendix semimonthly publication for five years and the author of articles on automatic machines. Mem. ASME, 1953. Member, also, ASTE.

Harry Brunt Newell (1884–1960), chairman of the board and president of the Ohio Forge & Machine Corp., Cleveland, Ohio, died Feb. 18, 1960. Born, Castle Shannon, Pa., July 6, 1884. Education, grade school and home study. An expert in engineering and production pertaining to drop forgings, gears, speed reducers, and special machinery, Mr. Newell was vice-president of the Fawcus Machine Co., Pittsburgh, Pa. He was earlier employed by Mesta Machine Co. Mem. ASME, 1920. He was a member of the Cleveland Engineering and Scientific Society. He is survived by a son, William H. B., Warren, Ohio; two daughters, Mrs. Dorothy N. Jenness, Yardley, Pa., and Mrs. Janet N. Cain, Pasadena, Calif.; a brother, Robert L. Newell, Pittsburgh, Pa.; and eight grandchildren.

Adriano Olivetti (1901–1960), president of C. Olivetti & Co., manufacturers of typewriters, office machines, and machine tools, died Feb. 28, 1960. Born, Ivrea (Torino), Italy, April 11, 1901. Parents, Camillo and Luiga (Revel) Olivetti. Education, Ingegnere Industriale, Politecnico di Torino, 1924. Mr. Olivetti inherited from his father a small typewriter factory in Italy and was credited with transforming it into one of the world's leading manufacturers of office machines and machine tools with nearly 25,000 employees in plants in Italy, Scotland, India, Spain, South Africa, and Argentina. In 1959 the Olivetti concern bought a 35 per cent interest in the Underwood Corp., another world-wide typewriter firm, to reorganize the operation as Mr. Olivetti had done at his own plant a generation before. Coming to America in 1925, Mr. Olivetti studied plant management and industrial methods. After returning to Italy the next year he reorganized his plant, pumped in new ideas, engaged scientific teams in design and research; costs decreased; output increased. In the Nineteen Thirties his new typewriter became a leader in the field. In 1934 he was named general manager and in the next 25 years his concern developed, manufacturing 18 business machines. In 1938 he became the company president. Mr. Olivetti's glass-walled plants, offices, and striking advertising art won him international fame. In 1952 he was honored with an exhibition of Olivetti products at the Museum of Modern Art in New York City. Later he received the Gran Premio Nazionale Compasso d'Oro from Italy; and, in 1956, the Grand Prix d'Architecture from the Cercle d'Études Architecturales of Paris. The National Management Association of the U. S. conferred on him its Edward O. Seits Memorial Award for leadership in international management and free enterprise in 1957. This Italian industrialist's energies went far beyond his business. After World War II he set up the National Institute of Town Planning and established small factories in rural areas to strengthen local communities. Interested in bringing vigor to impoverished Italian communities, he initiated a community plan, aimed at social, cultural, and political improvement in the democratic tradition. He set up more than 70 community-aid centers with libraries, educational courses, and lectures. Through the organization, Comunità, groups of experts are ready to lend agricultural, technical, and industrial advice to help a community with its rehabilitation program. Mr. Olivetti was the author of several books on the Community movement and owned the nonprofit Community Publications, which published *Community*, a magazine, and books on politics, philosophy, and art. He was elected Mayor of Ivrea in 1956. Two years later he was elected to the Chamber of Deputies. He was a Cavaliere del Lavoro and an Officer of the French Legion of Honor. Jun. ASME, 1926; Mem. ASME, 1951. He was president of Istituto Nazionale di Urbanistica. Survivors include his widow, a son, and three daughters.

John F. Potter (1924–1959), assistant to the vice-president, Product-Engineering Div., The Trane Co., LaCrosse, Wis., died Dec. 15, 1959. Born, Algona, Iowa, Jan. 10, 1924. Education, BS(ME) Iowa State College, 1944; attended Stanford Univ. Graduate School of Business. During World War II Mr. Potter was an ensign in the Civil Engineering Corps of the U. S. Navy. He was an instructor at Iowa State College for one year. Employed by What Cheer Clay Products Co., What Cheer, Iowa, for several years, he designed a machine employing hydraulic power to make small sewer-pipe fittings. Mem. ASME, 1953.

George Arthur Pugh (1897–1960), consulting engineer, Youngstown, Ohio, died Jan. 26, 1960. Born, Kingsbury, Que., Canada, April 6, 1897. Parents, David and Margaret (Hall) Pugh. Education, attended Oberlin College. Married Ellen G. Burton, 1922; children, George B., David A., and William R. From 1917 to 1926 Mr. Pugh was employed by Standard Engineering Co., Youngstown, Ohio, and became vice-president in 1929. In 1934 he went into private practice specializing in the manufacture of seamless and welded tubing and machine design for tube production. He was the coauthor of ASME paper, "Manufacture of Seamless Tubes," in 1927. Jun. ASME, 1919; Mem. ASME, 1951. Member, also, Engineers Society of Western Pennsylvania and American Iron & Steel Institute.

Carleton Allen Read (1868–1960), retired consulting engineer, Worcester, Mass., died March 3, 1960. Born, Hanover, Mass., April 23, 1868. Education, SB, M.I.T., 1891. Mr. Read had a long career in engineering education. He was an instructor in mechanical engineering at M.I.T. from 1891 to 1899 and later professor of mechanical engineering at the New Hampshire College. He retired from the faculty of Worcester Polytechnic Institute in 1934 after many years as professor of steam engineering and superintendent of heat and power. Jun. ASME, 1893; Mem. ASME, 1900. In 1958 Professor Read was awarded a 65-year ASME membership pin and certificate. He is survived by his widow, Abbie M. Read, three children, three grandchildren, and six great-grandchildren.

Stephen I. Rudo (1897–1960), director of research and development, Werner Textile Consultants, New York, N. Y., died March 10, 1960. Born, Budapest, Hungary, Sept. 25, 1897. Education, BS, Univ. of Budapest, 1920; MS, Univ. of Berlin, 1921. Mr. Rudo's career in textiles started in a weaving and dyeing plant in his native country and he was a partner for 20 years in the Grab Textile Works, Ltd., Gyoer, Hungary, which produced cotton and rayon fabrics. Before joining Werner Textile Consultants in 1949, he was a director of the International Braid Corp., Fall River, Mass., manufacturers of narrow fabrics. He was awarded two patents, one for a circular loom for weaving specialty fabrics. Mr. Rudo was known in textile circles through frequent articles on industry problems in textile trade papers. Mem. ASME, 1955. He belonged to several trade associations, including: American Association of Textile Chemists and Colorists, American Association of Textile Technologists, American Society for Quality Control, American Society for Testing Materials, Textile Quality Control Association, and Textile Institute of Manchester, England. He is survived by his widow, Ann.

John Scherner (1886–1960?), retired, died recently according to report received by the Society. Born, Drage, Germany, June 28, 1886. Parents, Peter and Urebke Scherner. Education, BS(EE) Univ. of Iowa, 1908; ME, Univ. of Iowa, 1912. Naturalized U. S. citizen, 1907. Married Magdalene M. Michels, 1913; children, Robert Eugene and Ruth Elizabeth. Mr. Scherner's career in the rubber industry began in 1909 with the Federal Rubber Co., Cudahy, Wis. In 1917 he joined the Fisk Rubber Co., Cudahy, Wis., and, in 1930, became mechanical superintendent in charge of power maintenance and engineering at their Chicopee Falls, Mass., branch. He held several patents on rubber machinery and equipment. Assoc.-Mem. ASME, 1917; Mem. ASME, 1920. Member, also, SAE, Sigma Xi, and Tau Beta Pi.

Donald Arthur Siedhof (1934–1959), flight test engineer, Convair Div., General Dynamics Corp., Fort Worth, Texas, died Nov. 7, 1959, in a mid-air explosion of a B-58 bomber. Born, Metal Township, Franklin Co., Pa., April 26, 1934. Education, BS(ME), Pennsylvania State Univ., 1956. Assoc. Mem., ASME, 1956. Survived by his wife.

John Frederick Smith (1904–1960), president, Compo Shoe Machinery Corp., Waltham, Mass., died recently. Born, Newcastle, England, Jan. 18, 1904. Education, public schools, Grange Town, York, England. Mr. Smith gained experience as apprentice machinist with George Lawley & Sons, Neponset, Mass., and in tool design with Rolls Royce of America, Springfield, Mass., and Perkins Gear Co., Springfield, Mass. During his employment with Reece Buttonhole Machine Co., he designed sewing machines. He joined Compo Shoe Machinery Corp., in 1933 as machine designer and was given charge of the engineering department in 1934. He organized a special patent department for the company which has built a successful business based on a process of cementing, rather than stitching, soles on shoes. He studied patents and patent law and became a registered patent attorney in 1936. He has been issued a number of patents. Mem. ASME, 1939. Member, also, Boston Patent Law Association and associate member of Engineering Societies of New England.

Baruch Spector (1883–1960), consulting engineer, Long Beach, N. Y., died March 1, 1960. Born in Russia, Sept. 15, 1883. Parents, Jacob and Eva Spector. Education, BS(ME), Cooper Union, N. Y., 1913. Married; children, Ruth and Herbert. For many years Mr. Spector was employed by Silent Watchman Corp., New York, N. Y., as inventor and designer. Previously he had worked for several companies designing tools and machinery. Later he worked for American Cutting Alloys, New York City, as consulting engineer; for E. W. Bliss Co., Brooklyn, N. Y., as designer and checker; George Scher Engineering Co., Newark, N. J., as process engineer, and Yale & Towne Manufacturing Co., New York, N. Y., as development engineer and consultant on mass production. He had contributed articles to *American Machinist* and *Machinery*. Assoc.-Mem. ASME, 1933; Mem. ASME, 1954. His wife, Mrs. Pearl Spector, survives him.

William Irving Westervelt (1876–1960), retired Brigadier General, U. S. Army and former director of research laboratories of Sears, Roebuck & Co. died in the Brattleboro Retreat, Brattleboro, Vt., March 2, 1960. Born, Corpus Christi, Texas, Sept. 11, 1876. Parents, George William and Ida Florence Westervelt. Education, U. S. Military Academy, 1900. Married Dorothy Jocelyn, 1918; three children. He was an instructor at the U. S. Military Academy, 1904–1906; inspector at Midvale Steel Works, 1906–1907; and until World War I had service at various arsenals. During the war he was assistant chief of artillery for the American Expeditionary Force in Europe and after the war, he was appointed to the general staff and became commander of the Army War College. While commandant of the Watervliet, N. Y., Arsenal from 1919 to 1923 he headed a board of officers that modernized the Army's field artillery. Most of the field pieces used in World War II were outgrowths of the board's recommendations. He was attaché for ordnance in the American Embassy, Paris, 1923–1927. General Westervelt retired in 1927 to become technical director of Sears, Roebuck & Co. In 1933 he went to Washington to direct the processing and marketing of the Agricultural Adjustment Administration and was a member of AAA's executive and commerical policy committee. He was affiliated with Ross & Co., New York, N. Y., after 1938. He held a number of military decorations from both wars including the French Officer Legion of Honor, the British Companion St. Michael and St. George, the Italian Commander of Crown; also the Victory Medal and Philippine Campaign Medal. Mem. ASME, 1915. Surviving are his wife; a daughter, Jane; a son, Peter J.; and two grandchildren.

Joseph Kaye Wood (1893–1960), vice-president and chief engineer of the General Spring Corp., New York, N. Y., died Feb. 29, 1960. Born, New York, N. Y., Feb. 22, 1893. Education, attended Cooper Union Day School, U. S. Naval School of Steam Engineering at Stevens Institute of Technology, and U. S. Naval School of Turbine Engineering at Carnegie Institute of Technology. Mr. Wood contributed greatly to various industries in the design and application of spring suspensions. He had 54 patents issued to him and was the author of 59 scientific papers and articles relating to springs, suspensions, and other mechanical devices. In 1928 the General Spring Corp. was formed for the purpose of marketing devices invented by him, particularly those implementing his design procedure now universally used in the suspension of high-temperature piping for the elimination of weight-transfer stresses and vibration. During World War II he developed devices such as the automatic valve shutoff for the protection of life against steam and fire hazards of piping failures. Early in his career Mr. Wood served as an engineer on the construction of rock and subaqueous tunnels in New York City. Later in the Bell Telephone laboratories he initiated the precision length measurement section. He proposed the formation of the Special ASME Research Committee on Mechanical Springs and served as chairman for seven years. He also served on the ASME Survey Committee. Assoc. Mem. ASME, 1923; Mem. ASME, 1935; Fellow, ASME, 1955. Member, also, The American Society of Naval Engineers, The American Petroleum Institute, Society of Naval Architects and Marine Engineers. Surviving are his wife, Mrs. Elizabeth Graves Wood, and a sister, Miss Susan C. Wood.

You get these benefits when you install YARWAY GUN-PAKT EXPANSION JOINTS

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

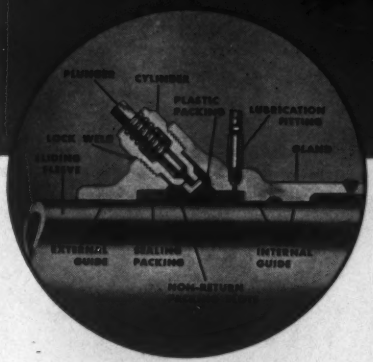
- **CONTINUOUS SERVICE**
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure.* No vents are necessary. Never needs repacking.
- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**
  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue.* Wrought steel bases provide rugged, positive anchorage.
- **INTERNAL AND EXTERNAL GUIDES**
  Positive alignment of sleeve in stuffing box *—where it counts!*
- **LIGHT WEIGHT, STREAMLINED DESIGN**
  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

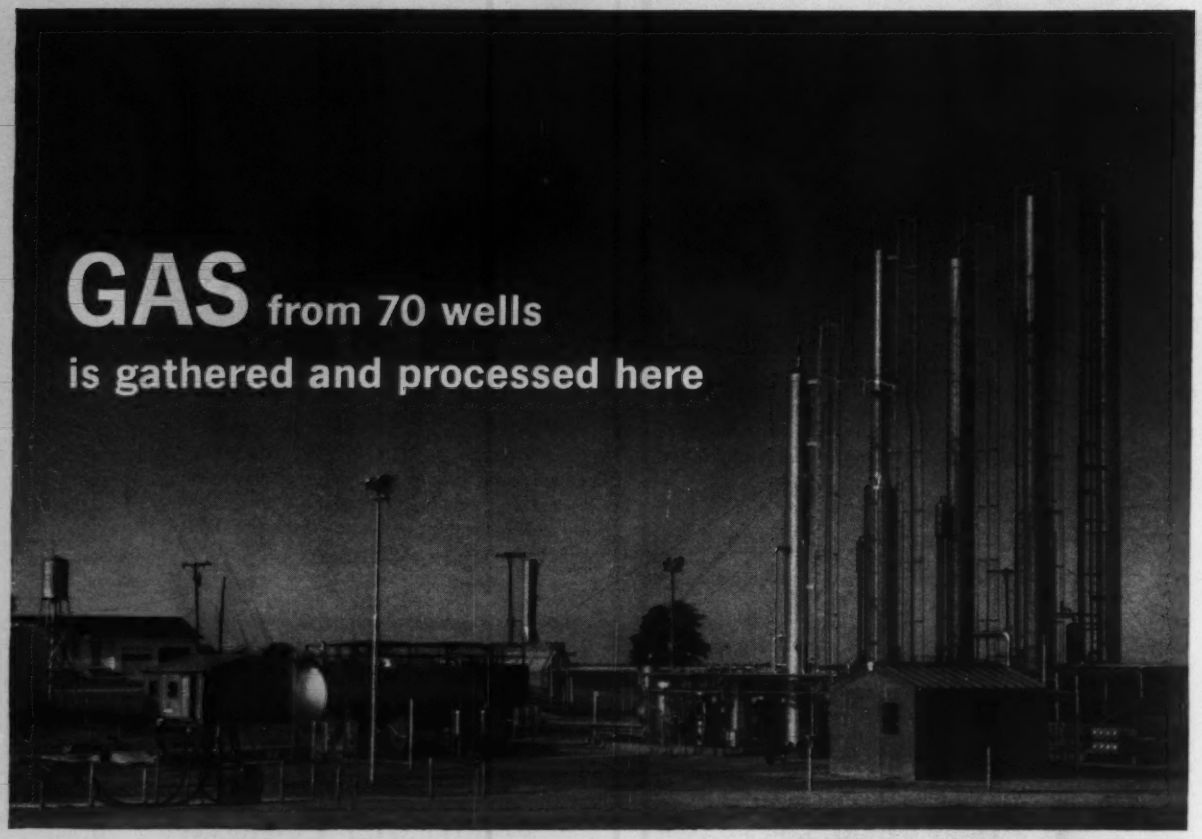
FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

YARWAY GUN-PAKT



"JENKINS valves give us the dependable performance our operations demand."

— states Kerr-McGee Oil Industries, Inc., Oklahoma gas producer

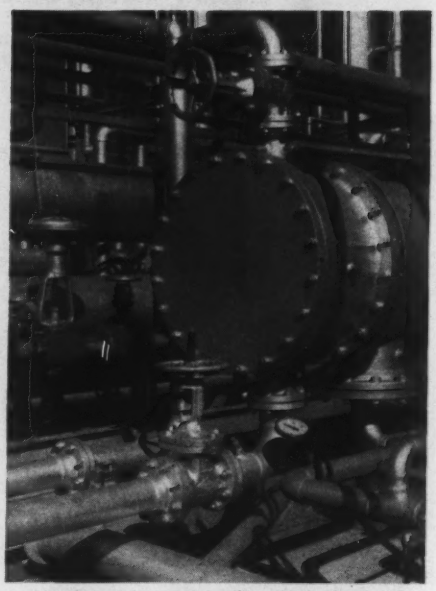
How Kerr-McGee's field processing plant in Lincoln County, Oklahoma, gathers and extracts valuable hydrocarbons from gas before delivering it to the consumer is an interesting story, briefly told below. But you need not know the process to appreciate the fact that maximum reliability in valves is a "must".

The valves that assure Kerr-McGee of dependable, trouble-free performance bear the same name as that written on piping lay-outs of critical jobs of all kinds for almost a century. Experienced engineers, contractors and operating executives know that "JENKINS" stands for an extra-measure of quality. They know it is the best guarantee of long, trouble-free service. There's no extra cost attached to this specification for extra quality, so you can use it for any job. Jenkins Bros., 100 Park Ave., New York 17.

HOW THE GAS PROCESSING PLANT WORKS...

Because it is a vapor at low pressure, gas is first compressed and injected into the bottom of a tall tower, called an absorber; oil is injected at the top. As the oil goes down, the gas goes up . . . the gas products are absorbed by the oil. The gas enriched oil is then processed to remove valuable light hydrocarbons.

Sold Through Leading Distributors Everywhere



Jenkins Gate Valves on lean oil cooler to the absorber

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS
SINCE 1864
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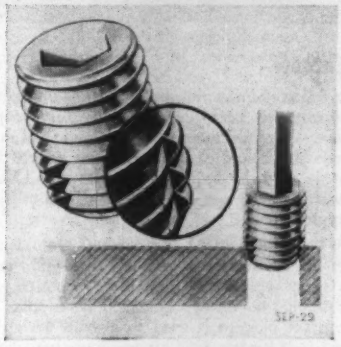
NEW EQUIPMENT



Set Screw

A self-tapping set screw designed to cut production costs and eliminate the tapping problem in most metals and plastics is announced by Set Screw & Mfg. Co. In addition, the company claims that the exclusive design of the cutting edges causes the screw to "pull-itself-in." Metal and plastic chips are gathered into the oversize flutes. The cutting-in action takes place at the lower three threads of the screw. It is possible to use this screw for standard applications as well. Can be used for sizing poorly tapped holes—and for easy insertion in paint-filled holes. Slabbed, slotted, or socket heads are available. —K–1

Slab, Bloom, and Billet Marker

An automatic stamper for steel-mill marking of slabs, blooms, or billets is announced by Jas. H. Matthews & Co. The unit functions when an operator sets the required mark at the remote-console selector, actuating an electronic-pneumatic cycle to index character wheels on the stamper corresponding to those selected. These characters appear before the operator in numerical indicator tubes for his inspection and verification of marking set-up. With the stamping head thus prepared, the indexing mechanism is disengaged and the impact thrust to produce the mark begins. When the mark has been made, the stamping head returns to be re-engaged for the next indexing. —K–2

Vibration Valve

The Model 2900 vibration valve is the latest addition to the Amot Controls Corp. line of safety and automatic system components for industry. Employed as a 2- or 3-way, snap acting, non-overlap vibration monitoring valve on pneumatic or hydraulic control systems to 80 psi, the unit is adaptable to engines, compressors, fans, motors, and other rotating or reciprocating equipment.

The unit may be applied as an accessory to the 1476 line of basic Amot controls, or it may be used by itself to energize auxiliary devices. Sensitivity of the valve is manually adjustable and it is sensitive to vibration from any direction in the plane perpendicular to its longitudinal axis.

An internal cylinder is provided in the standard Model 2900 which will reset the tripping mechanism, with the application of 40 to 80 psi. The reset cylinder may also be used in a time-delay circuit to prevent tripping of the valve on high amplitude vibrations during start-up. Write for Bulletin No. 493. —K–3

Tungsten-Carbide Balls

High-precision tungsten-carbide balls are now available from stock from Industrial Tectonics, Inc. Available in inch sizes are: $^1/_{64}$ through $^5/_{32}$ by 64ths; $^3/_{16}$ through $^1/_2$ by 32nds; $^9/_{16}$ through 1 by 16ths. Also available are 1, 5, and 10 mm. Any other size desired can be furnished on special order.

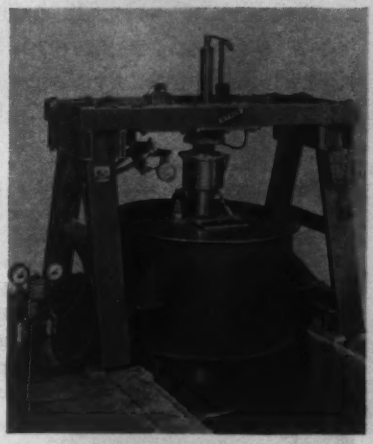
These balls are AFBMA Grade 25—of 0.000,025-in. sphericity, ±0.0001 in. basic size tolerance, and 0.000,050-in. uniformity per container. They are of unequaled hardness (89-91 Rockwell A), and are used as valve elements handling abrasive materials, as indicator points, in bearings at temperatures to 800 F, and in other applications requiring maximum wear resistance, smoothness, and strength. Surface finish is 1 microin. Increased production volume has permitted an average price reduction of more than 21 per cent for sizes from $^1/_{64}$ through $^5/_8$ in. —K–4

Cleaning Stand

The Industrial Model 80B cleaning stand recently introduced by the Fate-Root-Heath Co. is designed for cleaning motors, machine parts, gears, bearings, power tools, transmissions, engines, or other machine parts weighing up to 500 lb.

Equipped with a 16-gal cleaning-solvent tank, a long-life efficient motor-pump unit indefinitely recirculates up to 2 gal of solvent per min. An aerating nozzle pours a steady stream of cleaning solvent without spatter. Approved solvents meet all insurance requirements.

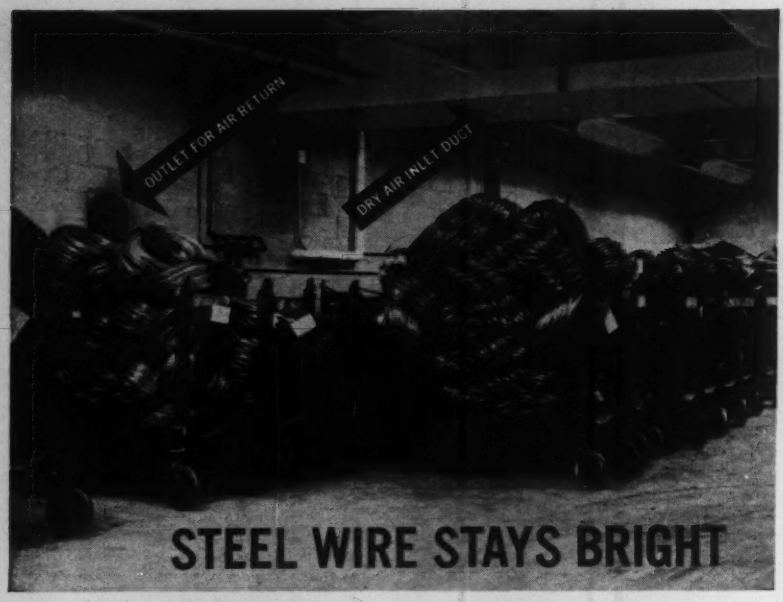
Dirt, grease, preservatives, and foreign matter are quickly flushed off any part or assembly. Overnight settling restores the solvent to its original color. Sludge which settles in the tanks can be removed periodically. —K–5



Centrifugal Dryer

The Hypar Model SCD, centrifugal dryer, recently developed by American Tool & Machine Co. does away with the usual discharger, eliminating possible damage to centrifugal screens and linings and also breakage and pulverization of crystalline products.

It is completely adaptable to any required degree of automation and can be loaded standing still or rotating slowly. Automatic discharge of bulkier solids is faster and easier because the bottom opens to full ID of the basket. The Hypar Model SCD is now currently being used for textile reclamation and also for difficult applications in the metal trades, food-processing, and chemical fields. —K–6

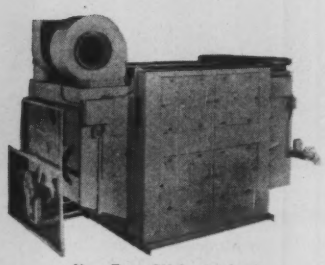


STEEL WIRE STAYS BRIGHT

IN DESERT-DRY WAREHOUSE

A LECTRODRYER maintains an average relative humidity of 16% the year around in Keystone Steel & Wire Company's storeroom at Peoria, Ill. As a result, bright steel wire exposed there to the atmosphere for a month was in excellent condition when received by the customer. Prior to dehumidification of the storage area, wire would begin to tarnish in a day or so.

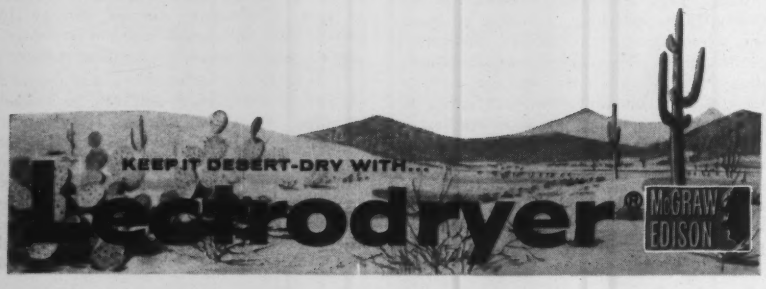
A DRY warehouse may solve your storage problems



New Type CH Lectrodryer

Hundreds of companies use Lectrodryers in a similar manner to dehumidify storage and work areas, thereby safeguarding products during warehousing, processing or packaging.

FOR CASE HISTORIES on these and for any other drying problem answers, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pennsylvania.



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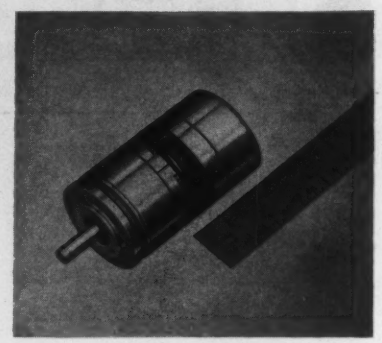

Encoder

A subminiature shaft-position-to-digital encoder has been announced by Librascope Div., General Precision, Inc. Packaged in a standard Size 8 casing, measuring only 0.75 in. in diam by 1.25 in. in length, the 13-bit unit is ideally suited for airborne and missile applications.

The Model 793M encoder has a resolution of 128 counts per input shaft revolution and a total capacity of 8192 binary counts. A combination of two cascaded disks and 25 contact pickups is used to provide serial or parallel binary readout representing shaft position or rotation. Accuracy can never be less than the least significant bit in 2^{13} counts.

Counting speeds of 0 to 200 rpm are possible. Tests conducted so far indicate a potential life of 2×10^8 revolutions at 200 rpm, equivalent to 167 hr of continuous operation.

The V-scan output of the encoder has been modified to permit serial readout with a minimum of external circuitry. An increasing count for either direction of rotation may also be obtained from the encoder.

The unit requires an exiting potential of 6 to 60 volts d-c with a maximum of 2 milliamp. Starting and running torques are both below 0.5 in-oz. The new encoder is designed for operation at ambient temperatures from −18 to +100 C under severe vibration and high-g loads. —K-7

Shock Trap

A Pulsco spherical shock trap of the water-gas interface type and utilizing the swirl principle reduces surge and eliminates water hammer and pipeline bursting. The unit is made by Pulsation Controls Corp. primarily for water application.

Guaranteed not to recycle, the Pulsco unit absorbs shock and surge resulting from kinetic energy by compressing gas within the chamber and by friction through a swirl chamber.

Built for design pressures to 200 psig and up, sizes range from 34 to 102 in. in diam. Write fro Bulletin No. 303. —K-8

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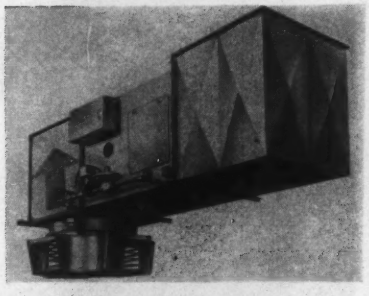


Air Supply Heaters

Gas-fired fresh air supply heaters with new high turndown ratios have been developed by L. J. Wing Mfg. Co. The high turndown ratio permits minimum temperature rise as low as 3.3 F, less than half that required by previously-available gas-fired equipment, allowing comfortable heating in mild weather. Fresh-air supply units provide warmed air to replace loss through exhaust systems, allowing exhaust systems to operate at rated efficiency and removing a source of drafts through doors, windows, and other openings to outdoors. In summer units may be operated without heating, to distribute fresh outside air.

Units are available in five sizes, from 15,000 to 50,000 cfm and 1.5 to 4.5 million Btu/hr, based on any clean gaseous fuel with a range of 800 to 3200 Btu/cu ft. Modular design simplifies installation and ready adaptability to roof or wall intake. Units are completely wired and piped for connection to gas line and electric supply. Units are available for 220, 440, or 550-volt, 3-phase, a-c. Burners for dual-fuel operation can be furnished. A wide choice of discharge arrangements is available, including the Wing revolving discharge which promotes even air distribution.

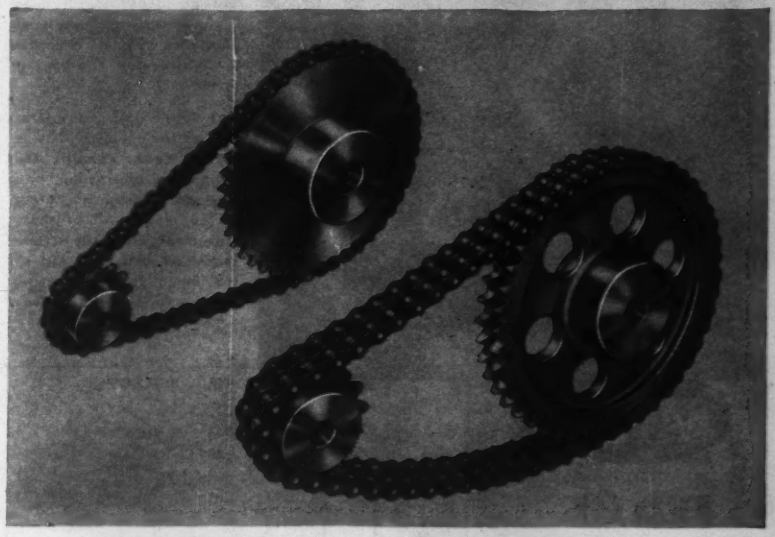
—K-9

Electrically Heated Gages

Electrically heated gages of a new, improved design made by Jerguson Gage & Valve Co. are indicated for installations where there is a problem of heating various liquids to get an accurate liquid level and steam is not available. They are also very practical for very close control of temperatures in the gage glass, and for cold-weather applications to prevent gage freezing and breakage.

The design employs a cartridge heater with a $\frac{1}{2}$-in-diam stainless-steel sheathed manganese-nickel wire. Each wire is insulated with silicone-impregnated glass. They are equipped for 120 volts, a-c, 60 cps, with wattage output to meet requirements. They are also available with temperature control within the gage column. Materials used conform to or exceed the requirements of AISI, ASTM, and/or API-ASME. —K-10

DO YOU HAVE THE PROPER CHAIN SELECTION FOR YOUR EQUIPMENT?



If there is a question in your mind about the correct size of chain to use for your particular installation, save time and money by consulting ACME Engineers at once. They will assist you in selecting the proper chain drive. In many instances, this depends on how much horsepower you want to transmit . . . the speed and size of your shaft . . . space limitations . . . hours of continuous operations, etc.

These are problems on which our engineers can draw from their many years experience to give you the correct answers.

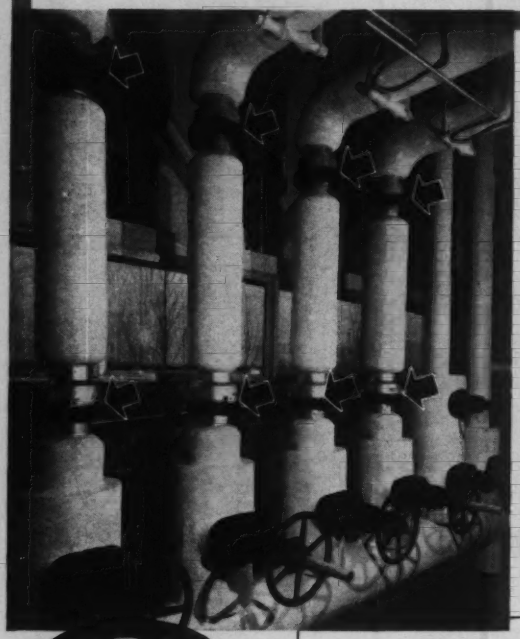
Consult your nearest ACME Distributor or write our Engineering Department for the answer to your CHAINING PROBLEMS.

Write Dept. 11-E for new 100-page illustrated technical catalog including new engineering section showing 36 methods of chain adjustments.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

Barco Solves Boiler Piping Expansion Problem



Relieves Strain on Valves

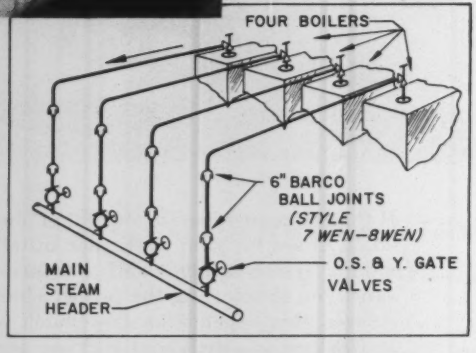
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the valves.

BARCO

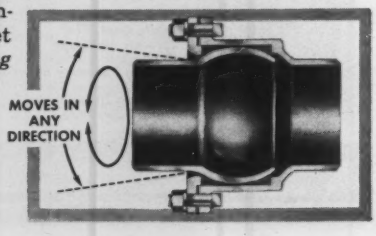
BALL JOINTS

1. Handle Expansion
2. Relieve Torsion



PROBLEM—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

ANSWER—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*



BARCO MANUFACTURING CO.
5216 Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

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Computer

A computer that is expected to make high-speed electronic data processing practical for more that 6000 of the 10,000 top companies in the U. S. has been introduced by Datamatic Div., Minneapolis-Honeywell Reg. Co. It is rated as able to perform 6000 operations per sec.

The "new-generation" computer is claimed to be the "most powerful available in the moderate-price field."

Known as the Honeywell 400, the computer broadens the company's line to include moderate-price as well as larger data processing equipment. —K-11

Water-Based Fluxes

New nonresinous water-based fluxes, developed by London Chemical Co. feature instantly soluble and noncharring residues, as major improvements over most exisitng water-based fluxes.

Known as Lonco Organo-Fluxes, they are available in four grades to provide sufficient activity for any job, while holding residues to an absolute minimum for the soldering speed required.

Typical applications include transistors, diodes, ceramic parts, magnets, refrigerator parts, prong soldering, canteens, roller soldering, terminal boards, connectors and electrical components. —K-12

Pillow Blocks

Bronze precision liners can be replaced quickly and easily in pillow blocks of a new design announced by Dodge Mfg. Corp., makers of a wide variety of mechanical power-transmission equipment.

The new sleeve bearings are recommended for applications where shock loads, elevated temperatures, and corrosive conditions are anticipated.

The new bronze-bushed line includes split journal bearings (two-bolt) for standard power-transmission shaft sizes from $1^{15}/_{16}$ to $2^{15}/_{16}$ in.; rigid pillow blocks (four-bolt) for shafts from $3^{7}/_{16}$ to 8 in., and angle pillow blocks for all standard transmission shafts. —K-13

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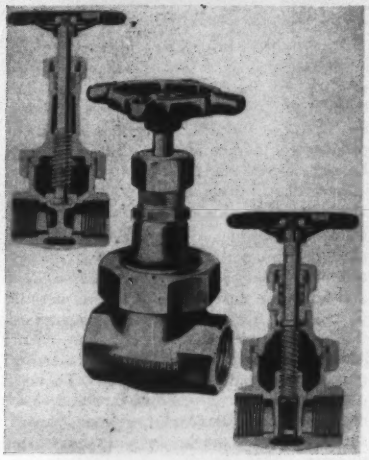


Gate Valve

A new series of Lunkenheimer Co. union bronze gate valves is especially suitable for all applications in the 125 to 150-psi steam-pressure range.

A chamfered opening provides more working room for positioning the disks on the guide when assembling the valve. Long pipe threads in the valve body permit tight valve-to-pipe jointing, without risk of pipe crowding and distorting the valve disks.

One model has double-wedge disks and rising stem. Another, especially recommended for food processing and lines handling gummy or tacky substances has solid-wedge disk and rising stem, and a third designed for installations in limited space has a single-wedge disk and nonrising stem.

—K–14

Work Base for Tester

Special tests of wire, ceramics, adhesives, steel, plastics, rubber, springs, and so forth often require bulky gripping and related instrument accessories. The new W. C. Dillion & Co. Xpandable work platform permits the proper set-up of this equipment by expanding the normal work area almost three times. It is portable and easy to install and facilitates almost unlimited tests of tensile, compression, transverse, and shear loadings.

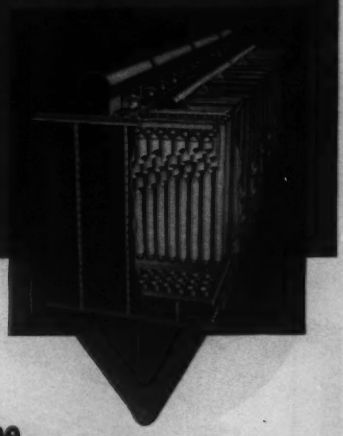
The above illustration shows a complete polarized light set-up for checking plastic specimens in tensile. The tester is 0–10,000-lb capacity. Also available in 0–250, 0–500, 0–1000, 0–2500, 0–5000 and 0–7500-lb capacity.

Dillion testers are hand operated or may be ordered motorized in four standard sizes with daylight openings of 13, 20, 30 and 40 in. There is a wide selection of gripping fixtures.

—K–15

Dust and Fume Collection by Norblo

helps you achieve efficiency and cleanliness in your plant



Norblo has developed bag type dust collection systems to a high degree of efficiency.

Norblo Automatic Bag Type

For continuous and heavy duty service at constant capacity and efficiency, Norblo Automatic Bag Type collection pays its own way — in recovery of valuable materials or removal of injurious or "nuisance" industrial air contaminants. Norblo builds the entire installation, from blowers to bag-cleaning mechanisms. Complete systems are engineered to meet specific situations. Norblo engineering insures low maintenance and no shut-downs — guarantees performance of every installation.

Norblo Standard Bag Type Collectors

Based on the same construction principles, the standard bag type collectors provide at low cost the high efficiency service that is obtainable only from bag-type cloth filtering, with either compressed air or electrically driven periodical bag shaking and cleaning. Units must be shut down for cleaning — at such times as the noon hour and end of working day.

Norblo Portable Type

For excellent results in localized dust control, Norblo Portables protect equipment and reduce maintenance in grinding, polishing and cutting departments. Six models cover capacities from 300 to 1350 cfm., at 8″ static pressure at the fan. Occupy small space. Are unusually quiet.

Write for bulletins describing Norblo bag type dust collectors

Northern Blower Division
Buell Engineering Company, Inc.
6409 Barberton Ave., Cleveland 2, Ohio • Olympic 1-1300

buell Norblo

Chace THERMOSTATIC BIMETAL

ACTUATES ANOTHER PRECISION PRODUCT

J-LINE

GAS-FIRED FURNACE

SAFETY PILOT

A PRODUCT OF JANITROL HEATING AND AIR CONDITIONING, A DIVISION OF MIDLAND-ROSS CORP. COLUMBUS 16, OHIO

When Janitrol designed the new J-LINE gas-fired counter-flow furnaces for basementless homes, they aimed at producing equipment to meet the highest contemporary standards for performance, economy and dependability. Precision-built throughout, the J-LINE models feature slim-trim styling, compactness, factory fire-testing, "deep well reservoir" pre-lubricated sintered bronze bearings for blowers, safe, sure, positive controls, acoustical insulation and, of course, a new safety pilot incorporating Chace Thermostatic Bimetal. The action of this sensitive bimetal element prevents the flow of gas to the pilot and the main burners should the pilot light be extinguished.

Here again is an example of precision control making an appliance so thoroughly safe that it is installed without hesitation by hundreds of thousands of contractors and home owners, usually close to the center of the living area itself. Janitrol buyers know that gas is the cleanest and *safest* of fuels because of Janitrol's specialized skill and experience in building home comfort equipment to highest quality standards for over half a century. Chace, too, has concentrated for over a third of a century on the development and manufacture of *one* outstanding product, precision thermostatic bimetal for thousands of applications — temperature control and indication and equipment protection. That's why Chace customers *know* their names are safe on the "outside" with Chace bimetal "inside."

If your new product is approaching the design stage, send for "Successful Applications of Chace Thermostatic Bimetal." It contains illustrations and design data on more than 30 types. Remember, too, Chace bimetal is available in strips, coils and in completely fabricated elements of your design.

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Thermostatic Bimetal

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KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Tube-Cooled Motors

Tube-cooled air-to-air heat-exchanger motors ranging up to 2000 hp, have been introduced by the Louis Allis Co. They are built both in standard enclosed construction for use in nonhazardous locations and in explosion-proof construction with Underwriters Laboratories Class 1, Group D label for use in hazardous locations.

Tube-cooled motors are designed to operate in unfavorable environmental conditions, providing protection against excessive moisture, oil vapor, chemicals, alkalies, coolant and air-borne dust, sand, dirt, and metallic particles. Tube-cooled motors have application in industries such as petroleum, chemical, mining and primary metal processing, machine tool and pulp and paper. They are used on pumps, compressors, fans and blowers, mixers, mills, crushers, conveyers, presses, special industrial machinery and refiners, and so forth.

Other features include an effective cooling system, corrosion-resistant construction, capsule-type split sleeve bearings and pressure lubricating systems with oil-level indicators. Ask for Bulletin No. 2400. **—K–16**

Noise and Vibration Probe

Electro Probe Model 101B anhounced by Erwood Inc. is an instrument for detecting, locating, and measuring noise and vibration in machines and mechanical systems. It is useful as a development and quality-control device to assure proper design as well as a noise-free product. On nonferrous grinding and burnishing machines it can be used to detect the point of contact of the grinding wheel or burnishing tool.

—K–17

Temperature Controls

Fenwal Inc. has announced four new transistorized temperature-control instruments. By employing interchangeable printed-circuit boards, the several models are available with a variety of modifications, and at competitive prices. The units employ factory calibrated thermistors which require no special installation techniques.

The Series 536 unit controller, for example, covers a temperature range from −50 to +600 F, with a sensitivity of 0.3 F and current-handling capacities of 10 amp, 110-volt a-c, and 5 amp at 230-volt a-c. It is a single-point controller with either ON-OFF or proportioning action. Set point can be adjusted by a potentiometer located within the case, on the front cover, or remotely. Other options include indication and expanded-range scales for fine temperature adjustment. The Series 536 is a companion unit to Fenwal's previously announced Series 535, which is a 5-amp controller without the multiple options.

—K–18

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST DATALOGS

Solids Processor

The Patterson-Kelley Co., has introduced a packaged solids processor for combining liquid-to-solids blending and vacuum drying.

Incorporating the liquid-dispersion features of the company's liquid-solids blender and the operating principles of the P-K vacuum tumble dryer, the new combination unit allows precision blending and drying of a variety of chemical formulations while minimizing materials handling.

A heating jacket has been wrapped around the V-shaped shell of the blender, and a vapor take-off connection and other dryer components have been added, including filters, condensers, receivers, vacuum pump, and instrumentation.

In operation, dry ingredients are charged from either of two openings at the ends of the V-shaped unit and solids can be tumbled to preblend for desired homogeneity under a variety of environments.

Liquids, such as alcohol, starch paste, gelatin, water, or other fluids which can be flowed or pumped, are introduced to the preblended mix through the unit's spinning cylindrical liquid-dispersion bar. The bar, equipped with precision-machined dispersion disks, provides a uniform distribution of liquids in the preblended solids.

Completely packaged systems of the new solids processor are available in standardized models with charge capacities ranging from 1 to 50 cu ft. —K–19

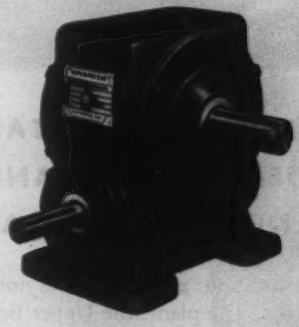
Direct-Reading Strain Gages

A photoelastic strain gage needing no external instrumentation or connections has been developed by the Electronics & Instrumentation Div. of Baldwin-Lima-Hamilton Corp.

Known as the B-L-H Strainline Photoelastic Strain Gage it is a direct-reading uniaxial strain indicator. Unlike other photoelastic strain devices, the Strainline gage indicates axial strain in the direction of gage application only. In addition to axial static and dynamic strains lateral bending and torque are also indicated. Two gage lengths or sizes are offered, 3/4 and 2 in. —K–20

Lindberg Roller Hearth Solution Treating Furnace, showing some of the 101 Winsmith Model 2CB Reducers which drive the rolls. An additional Model 7CT is also installed. The heating chamber of this furnace is 100 feet long with 40 feet of quench chamber.

LINDBERG ENGINEERING USES 102 WINSMITH SPEED REDUCERS *on their Roller Hearth Furnaces*



LINDBERG ENGINEERING COMPANY of Chicago is a leading manufacturer of heat treating furnaces. When they designed this one to handle 4,000 lbs. of aluminum extrusions per hour, specifications called for 101 speed reducers to drive the rollers. They selected Winsmith for compact size, rating and their record of past performance. Lindberg is a long-time Winsmith customer. They describe the relationship this way..."We have used Winsmith Reducers for many years and have found their reliability and ruggedness ideal for use with our heat treating furnaces."

Lindberg Engineering is another one of the leading American manufacturers who specify Winsmith Speed Reducers for most applications from 1/100 to 85 hp.—in ratios from 1.1:1 through 50,000:1.

WINSMITH SPEED REDUCERS

WRITE TODAY for complete selection information and engineering data. You'll see for yourself why it pays to standardize on Winsmith.

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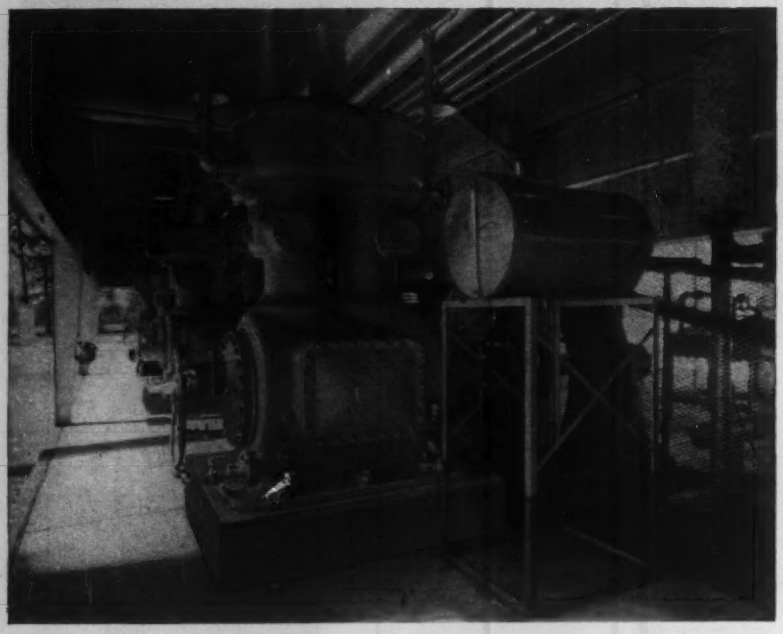
20 Eaton Street, Springville, (Erie County), N. Y.

364 TONS OF TRADE FRICK MARK® REFRIGERATION . . .



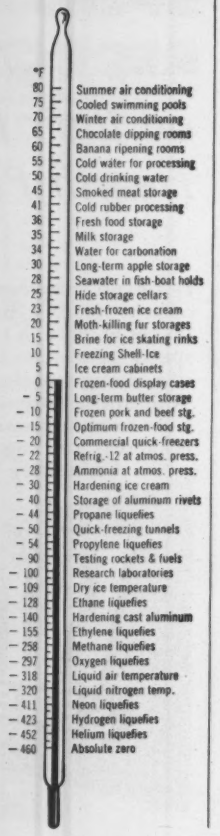
PRODUCE PROFITABLE YIELD OF PROPANE, BUTANE AND NATURAL GASOLINE

● The location: about 30 miles north of Lake Charles, Louisiana. The plant: the Upper Bearhead Creek Sand Unit, operated by H. L. Hunt. The refrigeration equipment: designed and manufactured by the Frick Company.

This is only one of several dozen natural gasoline plants equipped by Frick. Here, as in others, rich casinghead gas is compressed to 950 Psig. and then dehydrated with the temperature being lowered to about 0° F. in a gas chiller that uses ammonia as the refrigerant. This way, hydrocarbon liquids are condensed and then fractionated into Propane, Butane and natural gasoline.

If you have a refrigeration problem of *any* type, Frick has the answer. A Frick engineer will call and discuss it with you at your convenience. No obligation at all. Write:

FRICK COMPANY
Waynesboro, Pennsylvania


°F
80 Summer air conditioning
75 Cooled swimming pools
70 Winter air conditioning
65 Chocolate dipping rooms
60 Banana ripening rooms
55 Cold water for processing
50 Cold drinking water
45 Smoked meat storage
41 Cold rubber processing
36 Fresh food storage
35 Milk storage
34 Water for carbonation
30 Long-term apple storage
28 Seawater in fish-boat holds
25 Hide storage cellars
23 Fresh-frozen ice cream
20 Moth-killing fur storages
15 Brine for ice skating rinks
10 Freezing Shell-Ice
5 Ice cream cabinets
0 Frozen-food display cases
− 5 Long-term butter storage
− 10 Frozen pork and beef stg.
− 15 Optimum frozen-food stg.
− 20 Commercial quick-freezers
− 22 Refrig.-12 at atmos. press.
− 28 Ammonia at atmos. press.
− 30 Hardening ice cream
− 40 Storage of aluminum rivets
− 44 Propane liquefies
− 50 Quick-freezing tunnels
− 54 Propylene liquefies
− 90 Testing rockets & fuels
− 100 Research laboratories
− 109 Dry ice temperature
− 128 Ethane liquefies
− 140 Hardening cast aluminum
− 155 Ethylene liquefies
− 258 Methane liquefies
− 297 Oxygen liquefies
− 318 Liquid air temperature
− 320 Liquid nitrogen temp.
− 411 Neon liquefies
− 423 Hydrogen liquefies
− 452 Helium liquefies
− 460 Absolute zero

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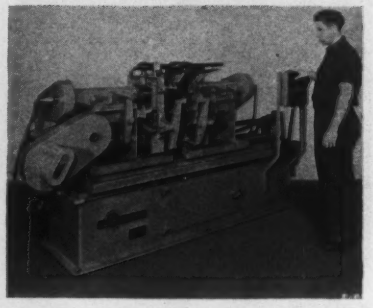
BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Deburring Machine

A versatile high-production Acme double-end deburring machine that automatically chamfers the ID, OD, and face of tubular-steel parts of various diameters and lengths is available from Acme Mfg. Co. Tubing from $^3/_4$ to $2^1/_4$ in. diam and from $2^1/_2$ to 24 in. long can be deburred by this machine at production rates up to 6000 pieces per hr. Fixtures are designed to permit rapid tool change from one tube diameter to another. No fixture changes are required for tube-length variations within a given tube diameter. The machine is completely mechanically operated to simplify operations and insure reliability.

The Acme double-end automatic deburring machine occupies a floor space of 3 by 9 ft and is $4^1/_2$ ft high. The spindles are powered by two 2 hp-1800rpm electric motors. The program shaft, which controls all automatic operations, is powered by one 1 hp-1800 rpm electric motor. **—K-21**

Dust Surveys

An air sampler called the Bantam Sampler, developed by Gelman Instrument Co., weighs 9 lb and samples air at the rate of 2 cfm. It fills the need for a lightweight air-cooled portable unit with a high air capacity which requires no lubrication. The flowmeter is directly calibrated in liters per minute. The sampler is supplied with a 1-in. open filter holder easily connected to the pump by a polyethylene press-fit coupling.

The Bantam Sampler is designed for hard usage. It is intended primarily for survey work where it will be used for an 8-hr working day. It can be used for longer periods, however, with some reduction in life of the motor windings.

The industrial hygienist, safety inspector, process engineer, air-pollution expert, anyone who is concerned with air quality will find this a valuable new tool. Intended primarily for 8-hr day use, it can be used for longer periods with some reduction in the life of motor windings.

The Bantam sampler is available for 110-volt a-c, 6, 12, and 24-volt d-c operation and in European voltages. **—K-22**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Sight Feed Bubbler

A sight feed bubbler featuring a built-in check valve is announced by King Engineering Corp. for controlling and visually indicating relatively small rates of flow in gas and air lines. Typical applications include bleeding air into lines to purge them of corrosive fumes or gases, and use with hydrostatic liquid-level gages hooked up for continuous gaging.

The entire flow of gas or air is passed through liquid in a transparent cylinder, and the rate of flow is shown by bubbles rising through the liquid. A needle valve at the top provides adjustment of flow from less than 1 bubble per sec to approximately 20 cu ft per hr. Water, glycerine, or any other noncorrosive liquid may be used.

Cylinders may be either 100-psi Pyrex or 200-psi plastic. There is a choice of four pipe connections, provided by two inlets (at left and rear) and two outlets (at right and rear), all 1/4 in. NPT. Over-all dimensions are $7^{11}/_{16}$ in. high, $2^{1}/_{4}$ in. wide and $2^{7}/_{8}$ in. front-to-back. Write for Bulletin 3285. —K-23

Flow Regulator

A flow regulator which controls flow as low as 35 cc per min has been announced by Fluid Power Accessories, Inc. It is especially applicable to machine tools, air-oil cylinders, and other operations where extremely low rates of oil or fuel flow must be controlled accurately.

A built-in check valve provides free flow with minimum pressure drop in the reverse direction. The valve is adjustable between 2 and 90 cu ipm. —K-24

Roller Bearings

Two new series of cage-type roller bearings are made by the Orange Roller Bearing Co. They are designed for applications requiring maximum radial capacity, have relieved-end rollers to minimize high stress concentrations and fatigue at corners. Rollers are of square-end type for maximum effective roller length and are retained in pockets of tubular steel cages to maintain alignment while running.

The MC series is interchangeable dimensionally with standard needle bearings in sizes from 1/2 to 2 in. shaft diameters, but uses larger diameter and longer rollers for increased load capacity. The HS series is an entirely new series of bearings made in inch sizes dimensionally between standard needle bearings and conventional cylindrical roller bearings, in a range from 1 to 2-in. shaft diameters. The HS series, intended for applications where radial space is available, is heavier-sectioned than the MC series and provides higher load capacity. —K-25

Contamination-free Compression—all types of gases:

CORBLIN Diaphragm Type Compressors

Now exclusively distributed in North America by the American Instrument Co., Inc.

- Outstanding Features: Absolutely no contact between gas and hydraulic fluid; gases are compressed between hydraulically-pulsed diaphragms.
- Compressors lend themselves to easy automatic operation when control is by pressure switch.
- Units can apply additional compression to gas taken directly from commercial bottles.
- Units operate efficiently with fluctuating input pressure, without need for pressure reducers or expansion vessels.
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Complete information in **Bulletin 4071A-3** *furnished upon request*

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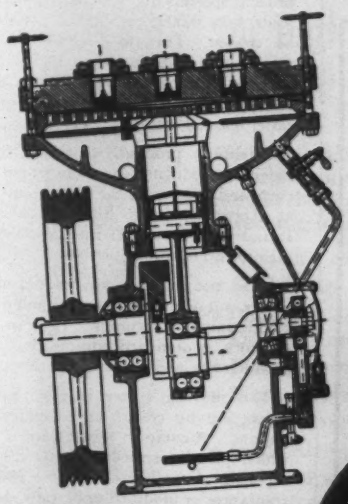

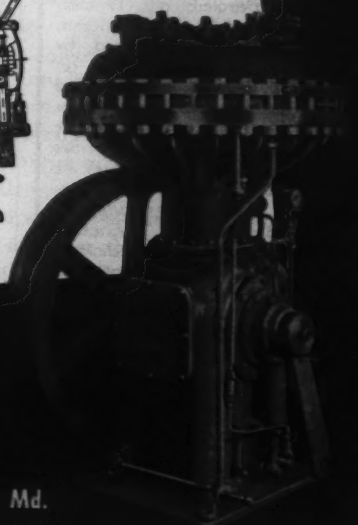

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VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Gear Shavers

A line of rotary gear-shaving machines, the 870 Mark II, featuring easier operation, greater compactness and rigidity, increased productive life, and greater precision is announced by Michigan Tool Co.

The line consists of three types of machines—an underpass, an internal, and a universal gear shaver. The Universal model permits selection at will of underpass, modified underpass, or transverse shaving. In addition, there are three sizes of machines—for gears up to 8, 12, and 18-in. diam respectively (up to 12-in. for internal gears).

The Mark II can be shifted from one size or type of gear or one processing method to another with ease. Feed rates of $^1/_2$ to 10 ipm can be selected to suit work conditions.

All controls and adjustments are easily accessible from the outside of the machine, speeding job changeovers. Gear face widths up to 5 in. can easily be shaved with Mark II. The automatic air-operated positive upfeed, located in the lower base, has been designed for faster operation and easier setup. Range is from 0 to 0.040 in. in increments of 0.001 in. Switches, timers, cams, and wrenches are unnecessary for setup. Initial (approach) speed is dial selected. Four fine upfeeds, from 0.0005 to 0.002 in. per stroke can be chosen. The rapid upfeed (0.040 in. max) which takes less than $^1/_2$ sec increases output. Compact design permits the operator to stand 8 in. closer to the work, for easier manual loading.

Maximum productive life has been provided by reducing the number of moving parts and employing the use of hard surfaces at all critical points. Rigidity is also greater. Initial accuracy built into the machine is maintained over long periods.

Head and tailstock are located above the cutter, out of the way of chips and dirt which could impair accuracy. An air-operated tailstock is standard equipment, increasing productivity and reducing operator fatigue.

The shaving cutter is easy to remove. There are no covers or coolant spouts to remove. A compact attachment is available which permits either or both crowning or tapering of teeth at the same time during transverse or modified underpass shaving.

Modular construction has been used throughout. All gears and bearings operate in sealed pump-type reservoirs, with visual sight gages provided. A central nylon-tube lube system is provided as standard equipment to lubricate all ways and miscellaneous moving parts. An internal magnetic chip separator can be added if desired.

The standard machine will be supplied with the following motors: (*a*) 2-hp 1800-rpm for main drive; (*b*) $^1/_2$-hp variable-speed for traverse feed; (*c*) $^1/_{10}$-hp 3600-rpm for coolant —K-26

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Dust Filter

The latest addition to the line of dust control equipment manufactured by the Day Co. is an improved "RJ" dust filter which incorporates a simplified method for maintaining the porosity of the filtering media. The filter has also been improved by the addition of a reverse-air-pressure blower, and newly designed air-tight, quick-opening inspection doors.

The "RJ" filter is available in five sizes for light or heavy-grain-loaded airstreams in capacities ranging from 285 to 6400 cfm of air at temperatures up to 300 F. Larger capacities are furnished by multiple groupings. Single units are supplied with round housings, while multiple units are furnished with square or rectangular housings.

The company reports this filter, with its combination of felted filter media and new high-velocity, counterflow air action, permits high filtering rates (air-to-cloth ratios up to 20 to 1) while operating at efficiencies of 99.99 + per cent. —K–27

Drill Presses

A new line of 20-in. power-feed drill presses, with up-front controls that permit one-hand operation, has been introduced by Rockwell Mfg. Co. Delta Power Tool Div.

Available in 18 models including bench, floor, and multiple-spindle and as an overhead track-mounted tool, the new machine is said to combine the adaptability of a power tool with the ruggedness and capacity of a machine tool. It has a connection from which automation devices such as rotary tables may be controlled and synchronized with spindle operation.

A unique front-mounted pilot-wheel control that is mechanically integrated with the clutch control, allows one-hand operation. There are four feed ratios—0.004, 0.006, 0.009, and 0.012 in. per rev—with each of the five spindle speeds.

The same pilot wheel is used for manual feed and no adjustments are needed to change to manual application. For rapid approach the cutting tool may be moved to the work manually before power feed is actuated.

A "cone-type" clutch permits the use of power feed on a production basis through a wide range of hole diameters. By a simple torque adjustment, the operator switches from a machine that delicately handles small drills in the $^1/_{16}$-in. range, to a machine delivering 1000 lb of thrust for drilling holes up to 1-in. in cast iron.

Primarily a metalworking production tool, the new press is also designed for use in tool shops, maintenance departments, and model shops where it can do a variety of metalworking jobs. —K–28

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for high quality, long wearing parts at low cost

Here are reasons why you will want to learn more about Shenango solid bars and centrifugally cast tubular bars for quality parts produced on your automatic screw machines or lathes:

- Available centerless ground or as cast
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- Choice of analyses—GC Meehanite, GA Meehanite, Ductile Iron, Ni-Resist, Ductile Ni-Resist
- Eliminates pattern equipment costs
- Increases production output
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- Fast delivery to exacting specifications
- Machines with a free-cutting chip, not a fine powder
- Special solid bar shapes available . . . hexagonal, square, rectangular and oval

Write on your letterhead for a machining sample. Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.

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POWER REACTORS
DESIGN and DEVELOPMENT

Combustion Engineering's Nuclear Division is expanding its activities in the design and development of high performance pressurized and boiling water nuclear power reactor systems for commercial and military applications.

Staff positions are now available to qualified nuclear, mechanical, electrical and chemical engineers for work in the following areas . . .

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REACTOR ENGINEERING DESIGN—Thermal, hydraulic, and mechanical design of nuclear reactor cores including steady-state and dynamic analysis.

NUCLEAR DESIGN AND ANALYSIS—Design of advanced reactor concepts and shielding employing high speed digital computers; analysis of nuclear fuel cycles.

Located nine miles from the center of Hartford, Connecticut, the Nuclear Division is within short driving distance of some 50 smaller communities. Boston and New York City are only two and one-half hours by car over four-lane divided expressways. Excellent housing and schools are available and New England's famous mountain and seashore areas are readily accessible.

Address inquiries to:
R. M. Killelea, Manager
Professional Recruiting
Nuclear Division
Combustion Engineering, Inc.
Windsor, Connecticut

NUCLEAR DIVISION
COMBUSTION ENGINEERING INC.
WINDSOR, CONNECTICUT

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Catenary Conveyer Carrier

Stephens-Adamson Mfg. Co. engineers have developed a new catenary conveyer carrier, known as Flexiroll, which provides true catenary suspension for the conveyer belt under all load conditions. It features a high-tensile spring-steel "dead shaft" to which is mounted a mild-steel trunnion and a shock-absorbing compressions spring. The shaft has an initial set providing a trough which enables the most rigid of belts to make contact with the face of all rollers when the belt is running under all load conditions. Consequently, the Flexiroll carrier supports the belt in a natural arc contributing to more efficient belt training and reduced belt wear.

The carrier rollers resist reaction to corrosive, abrasive, greasy, oily, and combustible materials. Natural flexing action of the carrier reduces material breakage, spillage and material build-up. The all-steel jig-welded frame is self-cleaning as is the roller assembly.

Greater strength than conventional catenary carriers is provided through the use of the solid spring-steel shaft rather than a steel cable which is subject to breakage through constant flexing action.

The Flexiroll carrier is available for 18, 20, 24, 30, and 36-in. belt widths. —K–29

Crankcases

A standard Two-Way Precision Boring Machine built by the Ex-Cell-O Corp., does one of the most critical operations performed during the machining of any four-cycle gasoline engine, the precision boring of crankshaft and camshaft bearing diameters. Two workpieces are involved, one right-hand, one left. The Ex-Cell-O designed fixture accomodates both aluminum-alloy components interchangeably. Changeover for one batch to another involves only a change of boring quills.

In operation, two workpieces are manually loaded and location is taken from two previously bored dowel holes. The clamps are swung into closed position and locked hydraulically. The left slide moves rapidly into working position and precision boring of the camshaft hole is performed in addition to facing the boss and chamfering. Tolerance on hole diameter is held within 0.0005 in.

The crankshaft bearing diameter is precision bored from spindles mounted on the right slide where a counterboring and chamfering operation is also performed. Hole-diameter tolerance is held within 0.0003 in.

This cycle of precision operations is made in a total time, including load and unload, of only 27 sec, achieving a gross production of 266 parts per hr. —K–30

For Consulting Engineers
Turn to Page 188

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Disconnect Switch

Introduction of new 5 and 15-kv indoor and outdoor switchgear, Type P, with rollout load-break disconnect switch for convenient maintenance has been announced by Allis-Chalmers Mfg. Co.

Basic available circuit arrangements include a single unit with line and load connections from above or below; a feeder unit, including main bus and load connections from above or below; a load-center substation transformer unit with 82-in. (floor to center-line) throat connection to transformer, left or right hand, and line connection from above or below, and an auxiliary unit to house instrument transformers and other accessories.

All units have a metering compartment at the top with 20-in. panel space and approximately 8-in. clearance behind the panel. Units without transformer throat connections have more than 12-in. clearance. —K–31

Power Chucks

A heavy-duty power chuck with jaws that freely index under full pressure has just been announced by the Skinner Chuck Co.

Available in body diameters from 12 through 36 in. and in all intermediate diameters, the new chuck lets the operator index manually without touching the work or releasing the pressure. Jaws can be indexed simply and fast by means of a lock screw and slide plate. The size and shape of the indexing pin is designed to fit firmly and positively into the indexing plate so that extreme accuracy is assured.

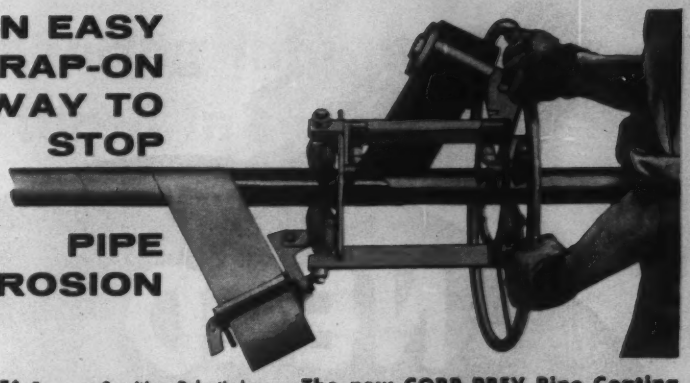
One or both jaws can be furnished with indexing mechanisms. As a result, the operator can index more positions and smaller index angles. This design eliminates the need for more than one chuck—index jaws or index components can be interchanged quickly and easily. —K–32

Pneumatic Control Stations

A line of pneumatic control stations for "bumpless" transfer between automatic and manual operation as well as for set-point loading and manual loading has been introduced by Republic Flow Meters Co., a subsidiary of Rockwell Mfg. Co. Designed to operate with Republic's Vector Series instruments and controls, the new control stations are accurate within 1 per cent of full scale. The controlled variable is indicated on automatic and manual operation.

Control stations have input and output ranges of 3 to 15 psig, with air consumption of less than 0.2 scfm. Red outer pointer indicates manual loading pressure and black center pointer indicates automatic loading pressure. Control stations are designed for standard panel mounting in $5^1/_4 \times 5^1/_4$ cutouts or space. —K–33

AN EASY WRAP-ON WAY TO STOP PIPE CORROSION



CHASEKOTE* Pressure-Sensitive Polyethylene Tape has an extra-heavy adhesive mass that clings to clean pipe on contact . . . makes a perfect, permanent bond that rustproofs, waterproofs and insulates pipe against all types of corrosion.

CHASEWRAP* Protective Overwrap is a tough, wrinkle-free outerwrap that shields against abrasion, wear, and physical damage to the tape. Wraps simultaneously with the tape. Superior to rag and felt wraps, yet far lower in cost.

*Trade name of Chase & Sons, Inc., long-famous for protective and insulating tapes for electrical wire and cable.

CORR-PREV DIVISION

The new CORR-PREV Pipe Coating Team comes in easy to handle tape form. It goes on pipe faster and lasts longer than corrosion-proof paints. It's cleaner and simpler to apply, too, than hot tar coats. And most important, this new CORR-PREV Team offers all the cost-cutting, pipe-saving advantages of polyethylene tape.

With CHASEWRAP Abrasion-Resistant Overwrap and Chasekote polyethylene tape, you get the easiest and best pipe protection at lowest applied cost! There's no heating, drying, clean-up or shut-down time. Each roll is factory-uniform in thickness and quality. And all coating materials — including rental of high-speed applicators — are available from one reliable source. Want samples? Specs? Prices? Write **CHASE & SONS, INC., 26 Spruce Street, North Quincy, Massachusetts.**

FOR YOUR ELECTRICAL INSULATION PROBLEMS SPECIFY CHASE FRICTION, PLASTIC, RUBBER, NEOPRENE & BUTYL TAPES

DISCERNING DRAFTSMEN THE WORLD OVER DEMAND IMPERIAL THE WORLD'S FINEST TRACING CLOTH

Eliminate "high-cost specials" by standardizing on

AMERICAN STOCK GEARS

Investigate and you'll probably find that instead of having to go to the added time and expense of ordering special gears, that your needs can be filled from the American line.

American is a 'complete' stock gear line. Manufactured by Perfection — a veteran of over 30 years in the gear business — these gears are made to the most precise standards, from the highest quality materials. This popular line includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in a range of 48 to 3 diametral pitch.

You'll save time and money . . . save on inventory . . . simplify purchasing and have less lost production time by procuring your stock gear needs from your nearby distributor of American Stock Gears.

Ask for FREE copy of American Stock Gear Catalog No. 360 containing detailed information and engineering data.

AMERICAN STOCK GEAR division
Perfection Gear Co., Harvey, Illinois

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

High-Torque Motor

The RBC-2410 low-inertia instrument motor manufactured by the Holtzer-Cabot Motor Div., National Pneumatic Co., provides the unusually high starting and running torques, coupled with low coast when de-energized, that are required in most remote-positioning and control applications. Available with heavy-duty gear reductions from 4/1 to 1800/1, total space required by motor and gear case, less output shaft, is only $4^1/_8 \times 4^1/_8 \times 4^5/_8$ in. Typical performance ratings are 750 oz-in. minimum starting torque and 350 oz-in. running torque at 6 rpm and 50 per cent intermittent duty. **—K-34**

Pressure Cell

A low-capacity, high-accuracy pressure transducer has been developed by the Electronics & Instrumentation Div. of Baldwin-Lima-Hamilton Corp. to accurately measure differential, absolute, or gage pressures.

The pressure cell, known as the Type MM, is of the bellows type and is suitable for most industrial, military, and laboratory applications. It is specifically recommended for missile and aircraft wind-tunnel research where high performance is a major requirement. It requires less space, maintenance and care than a mercury manometer. The electrical output may be translated for direct input to data-reducing equipment.

Strain gages, bonded to an element which is contained within a hermetically-sealed metal case, undergo resistance changes when the bellows assembly applies a force to the element. This resistance change is directly proportional to pressure.

Features are high output 3 mv/v, 350-ohms input impedance, standardized performance complete interchangeability, high accuracy, and terminal linearity within $\pm^1/_{10}$ of 1 per cent of full scale. Cell capacities are ±15, 30, and 60 psi. The unit operates on line pressures up to 90 psi. **—K-35**

Discharge Gage

A compact, rugged cold-cathode-type discharge gage for the accurate and uniform measurement of high vacuum has been introduced by F. J. Stokes Corp. Designated Model DG-10, it combines the accuracy and dependability of ionization-type gages with unique design and construction features. It is flexible in application, easy to maintain, and economical and has a wide range—from 10^{-1} to 10^{-6} mm Hg.

The gage tube and the control circuit and meter are basic units of the system. A voltage introduced between the cathode and anode of the gage results in a d-c current proportionate to the amount of gas present, which in turn is the pressure. An easy-to-read triple scale provides direct-reading indication of pressures throughout the entire range of the gage. **—K-36**

Need more engineering information on products featured in this issue?

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If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or

detailed in the Keep Informed Section

. . . . . circle the page numbers of these advertisements or items on one of the cards below . . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

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Code number identifies location of item in Keep Informed Section—beginning page 135

MECHANICAL ENGINEERING—JUNE 1960—Products Advertised

1	17	29	40	139	151	161R	174	191
2	18, 19	30	41	140	152L	162L	175	192
4	20	31	42	141	153R	162R	177	IFC
6, 7	21	32	43	142	154	163	178TL	IBC
8	22, 23	33	44	143	155	165	178BL	OBC
9-11	24	34	133	144TL	156	166	178B	
12, 13	25	35	134	145	157	168	179TL	
14	26	36	136	147T	159	169	179B	
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MECHANICAL ENGINEERING—JUNE 1960—Keep Informed Section

K-1	K-11	K-21	K-31	K-41	K-51	K-61	K-71	K-81
K-2	K-12	K-22	K-32	K-42	K-52	K-62	K-72	K-82
K-3	K-13	K-23	K-33	K-43	K-53	K-63	K-73	K-83
K-4	K-14	K-24	K-34	K-44	K-54	K-64	K-74	K-84
K-5	K-15	K-25	K-35	K-45	K-55	K-65	K-75	K-85
K-6	K-16	K-26	K-36	K-46	K-56	K-66	K-76	K-86
K-7	K-17	K-27	K-37	K-47	K-57	K-67	K-77	K-87
K-8	K-18	K-28	K-38	K-48	K-58	K-68	K-78	K-88
K-9	K-19	K-29	K-39	K-49	K-59	K-69	K-79	K-89
K-10	K-20	K-30	K-40	K-50	K-60	K-70	K-80	

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Metering Valve

To meter the flow of water in small-diameter hose and tubing applications Robert Mfg. Co. has introduced a brass metering control valve available in various sizes. Turning the valve stem through 180 deg controls the valve from full flow to maximum restriction.

The stem end of the valve can be used with or without a knob. Without the knob a permanent setting can be maintained.

—K–37

Straightening Press

Watson-Stillman Press Div., Farrel-Birmingham Co. announces a 200-ton hydraulic C-frame straightening press constructed of heavy welded sections, stress-relieved to provide maximum resistance to deflection under load, with a steel-weldment press table machined to present a smooth pressing surface.

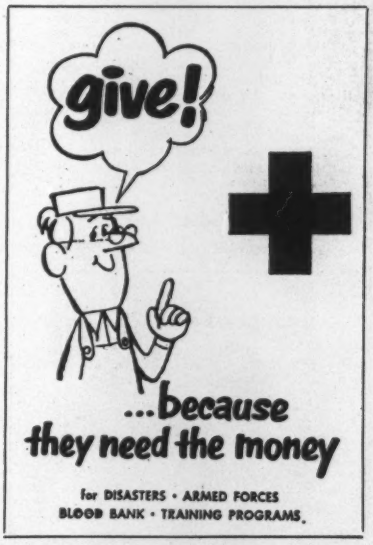
Hydraulic pressure is provided by a vane-type pump connected by a flexible coupling to a 10-hp 1200-rpm electric motor. Motor is complete with a starter and pushbutton station which operates on 440-volt, 3-phase, 60-cps current.

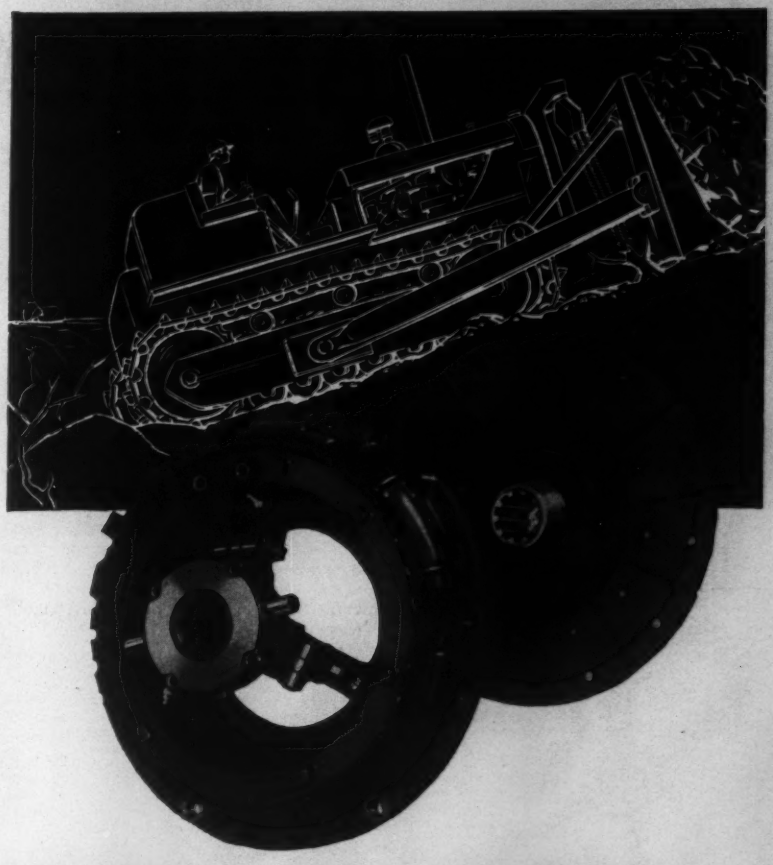
A hand-lever control is connected to a 4-way valve which governs the direction of the oil flow between the pump and the cylinder. This provides the operator with a sensitive, quick-acting control of the ram movements.

Stroke of the press is 18 in., daylight opening 18 in., gap 72 in., ram pressing surface 24 × 6 in., and operating pressure is 2000 psi.

Speeds are: Advance 250 ipm, press 8 ipm, and return 86 ipm.

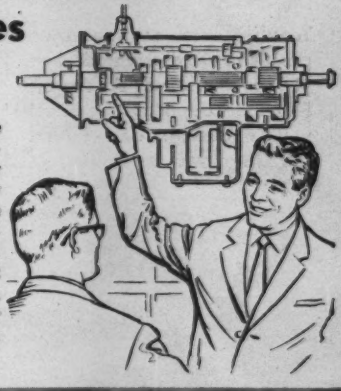
—K–38





BETTER COMPONENTS...
BETTER PRODUCTS!

Cooperation produces the final design



When each component part is the best, the whole machine is right. Rockford Over-Center Clutches are the finest made for crawlers, cranes and other heavy-duty equipment. If your equipment is in the design stage, let Rockford Clutch engineers help you select the best clutch. Rockford Clutches in standard sizes suit almost every need. Custom models can be designed for your applications. Call or write for the Rockford Clutch Catalog.

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1307 EIGHTEENTH AVE.
ROCKFORD, ILLINOIS

Export Sales
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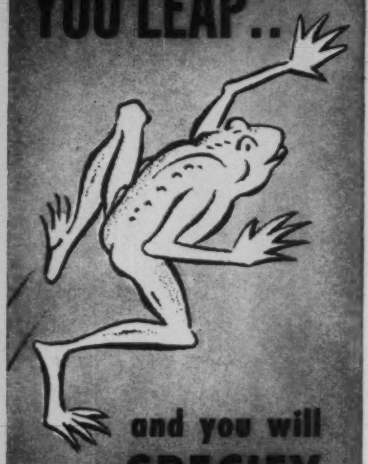
36 So. Wabash, Chicago, Ill.

LOOK BEFORE YOU LEAP..



and you will SPECIFY THOMAS FLEXIBLE COUPLINGS

It is just plain common sense to "Look before you leap" when selecting a flexible coupling.

An inferior coupling causes wear and damage to your machines — resulting in high maintenance costs and costly shut-downs.

Troublesome maintenance problems are eliminated when you specify Thomas "All-Metal" Flexible Couplings to protect your equipment and extend the life of your machines.

NO MAINTENANCE
NO LUBRICATION
NO WEARING PARTS
NO BACKLASH

Write for Our New Engineering Catalog 60

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Pancake Motor Base

For use in variable-speed sheave installations where space is at a premium, sliding motor bases of the low "pancake" type are announced by T. B. Wood's Sons Co. An attractive feature is the provision for rapid release of the adjusting screw. The motor base can be moved quickly and easily to shorten center-to-center distance and free V-belts from the grooves for sheave adjustment.

The new Quick-Slide bases are extraordinarily low. Height is only $1^{9}/_{16}$ or $1^{21}/_{32}$ in., depending on NEMA motor frame number. Amount of movement is either $4^{1}/_{2}$ or 6 in. again depending on NEMA motor frame number. Bases with 9-in. movement can be furnished on special order. The top plate of the motor base is drilled to accommodate various combinations of NEMA motor frames.

"Quick-Slide" bases may be used with any V-belt drives but are particularly designed for use with variable-speed drives where it is necessary to vary the center distance between sheaves with pitch-diameter changes. —K–39

Specialty Primer

A specialty cold-applied, inhibitive primer has been formulated by Koppers Co., for use in contaminated industrial or marine atmospheres.

The new primer, Bitumastic 11-S, serves a dual role: (*a*) As a shop primer it prevents contamination from attacking the surface before the protective coating can be applied; (*b*) it avoids undercutting where mechanical damage produces breaks in the protective coating, after application.

Results are good even where the surface preparation of the metal is less than ideal. No claim is made that it will penetrate heavy rust, but it has been successful in passivating the metal and preventing the further development of rust tubercles. —K–40

Spray Lubrication

Where frequency of lubricating single, heavy-duty gears is no problem but inaccessibility presents a danger to maintenance personnel, a new, versatile spray system, announced by Farval Div., Eaton Mfg. Co., offers an inexpensive efficient method of lubrication.

The lubricant is applied with a hand grease gun attached to a conveniently located fitting. Lubricant is sprayed as long as pumping is continued. Lubricant pressure forces down a spring-loaded piston, opening porting to the spray-control valve. This allows air and lubricant, each under its separate pressure, to be forced through the spray nozzle. When lubricant flow ceases, the piston returns to its original position, closing the ports. The air supply is then shut off, limiting compressed air consumption to the amount needed for each delivery of oil or grease. —K–41

An ASME Publication

SPRAY LITERATURE ABSTRACTS

Here, for the first time, is a comprehensive source-book on the multitudinous applications of sprays and their scientific, technical and industrial aspects. The compilation comprises over 1300 items collected from the technical literature of 24 countries, published from 1880 to 1958 inclusive. The abstracts are detailed, contain full bibliographic data, as well as information on the affiliation of each author wherever available. Entries include:

- fuel sprays for furnaces, internal combustion engines, gas turbines, and rockets;
- sprays in industrial processes for evaporation, drying, humidification, cooling, air conditioning, and chemical reactions;
- atmospheric sprays, as rain, fog, haze, sleet and snow, their formation, evaporation and freezing;
- agricultural sprays for sprinkling, pest, fungus, and weed control;
- fire-fighting sprays, as in sprinkler systems and in fire-smothering fogs;
- aerosols for medical, disinfecting, therapeutic, and air conditioning purposes;
- sprays and fogs for military purposes in defense and attack.

Other entries direct attention to published information having a bearing on the theoretical and experimental study of sprays; in particular:

- mathematics, ranging from arithmetics to statistics and probability theory;
- physics and chemistry, dealing with the properties of liquids and gases, especially the science of colloids and other disperse systems;
- hydro-, aero-, and thermodynamics, and rheology, dealing with the motion of liquids in spray-generating devices, the breakup of liquid stream into drops, and their motion in air, their evaporation and combustion;
- optical and electronic devices for the experimental study of sprays;
- branches of mechanical and production engineering concerned with the design, production, and testing of pumps, nozzles, and other elements of spray generating equipment;
- borderline and associated disciplines, such as the science and technology of powders and dusts.

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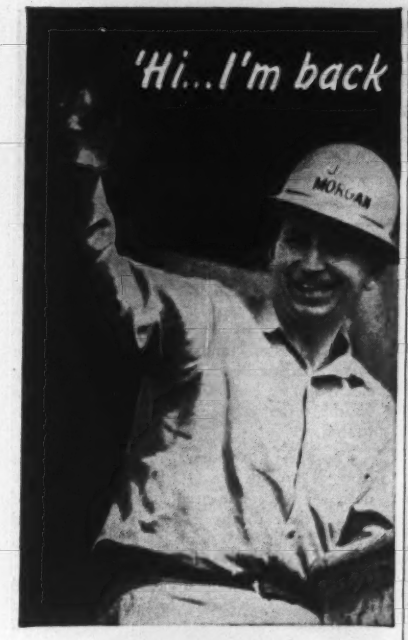


SURE...I had a heart attack'

Jack Morgan, oil worker, is one of thousands back at work after a heart attack.

New drugs, new treatment, the latest knowledge developed through heart research helped pull them through.

You don't have to have heart disease to appreciate the story of Jack Morgan and the value of research supported by the Heart Fund. Whatever your job, your life depends on your heart. Whatever protects your heart is a sound investment in your future.

HEART DISEASE #1 Enemy

GIVE

HEART FUND #1 Defense

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Flexible Couplings

Flexible tube couplings, mechanically attached without flare or beads, and made by the Gamah Corp., provide an extremely low weight-to-strength ratio. They are approved to MIL-C-25104 specification, provide a no-leakage seal under extreme conditions of pressure, temperature, and vibration in a variety of fluids including aromatic fuels and Freon 12. A special swaging method makes the fittings literally a part of the tubing.

The couplings cover a pressure range up to and over the burst value of the tube, with $^1/_4$-in. axial motion and up to 8-deg angular flexibility. They are available in $^3/_8$ to 5-in. sizes inclusive for temperatures from −70 to +450 F. —K–42

Radiation Monitor

A wristband holder has been designed to monitor radiation when handling radioisotopes—especially beta emitters—or in lining up diffraction instruments, and whenever the hands are closest to a radiation source.

Made by St. John X-Ray Laboratory, the holder is designed to be worn on the palmside of the wrist, where all parts of the holder will receive uniform exposure. It can accommodate two filmbadges—one to check weekly exposures and one to be used as a 13-week badge. —K–43

Socket-Head Screws

The Continental Tool Wks. Div., Ex-Cell-O Corp. is producing a set of counterbores consisting of sizes arranged to suit the new standard for socket-head screws.

The latest, 1960 series, socket-head cap screws are manufactured in most cases with larger head diameters, carefully calculated to ensure that the screw will carry an even greater load and yet not indent the material being fastened.

The No. 1B standard tool room set, comes in an oak box containing counterbores to suit screw heads No. 6 through $^5/_{16}$-in. diam together with necessary pilots and holders. Three countersinks for 60, 82, and 90 deg included angle are also provided. The original Continental No. 1 standard tool room set will continue to be available. —K–44

Reversing Starters

A line of reversing starters which cuts panel space nearly 50 per cent has been developed by Square D Co. They are designed for piggy-back mounting so that they occupy practically the same space as nonreversing starters. All load and control connections are made from the front for easy wiring.

They are available in NEMA Sizes 0, 1, 2, and 3, with either melting alloy or bimetallic overload relays. The devices also are available as reversing contactors. —K–45

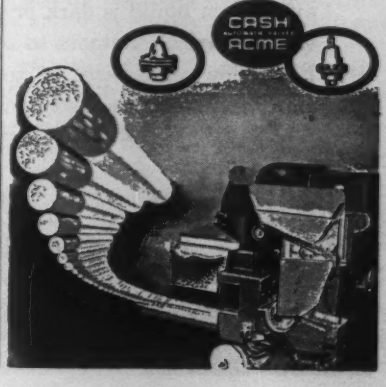
CASH-ACME ... meeting pressure control needs for product design engineers everywhere

To keep pace with fantastic demands for filter tipped cigarettes (now 40% of the market), manufacturers are attaching a new kind of tipping device to machines — capable of tipping 780,000 cigarettes in a 10-hour run

Designers give a lot of credit for the device's amazingly foolproof performance to Cash-Acme engineers. An extremely exact "low whisper" vacuum must be maintained at all times... just enough to hold the cigarette while the filter is affixed. This is assured by strategic placing of Cash-Acme Regulator Valve D-51 on the machine's vacuum line which brings high vacuum from the plant's central system. By regulating and keeping the vacuum at the proper level, all chances of "jamming" and production loss are eliminated.

TYPE D-51 VACUUM REGULATING VALVE Ready for exacting vacuum regulating jobs on any type of equipment. Type D-51 is expressly designed for use in systems where it is desired to maintain, automatically, a lower vacuum at the valve inlet than prevails at the source on the valve outlet. No step-action, no snap-action, but full-floating and automatic.

A. W. CASH VALVE MFG. CORP.
6627 East Wabash Ave., Decatur, Ill.



KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Power Gas Conversion Burner

Mechanics, operation, and installation of the new Lennox Industries Inc. power gas burner Sure-fire electric ignition and wide input range (75,000 to 250,000 Btu per hr) with all gases are features. Ask for Bulletin No. GC-571-M8. —K–46

Copying Drawings

A camera-projector—the first capable of utilizing both 105-mm and 35-mm film in its operation—available from Keuffel & Esser Co., is the first planetary camera with a subject area (44 × 64 in.) which fully covers 42-in. tracings. —K–47

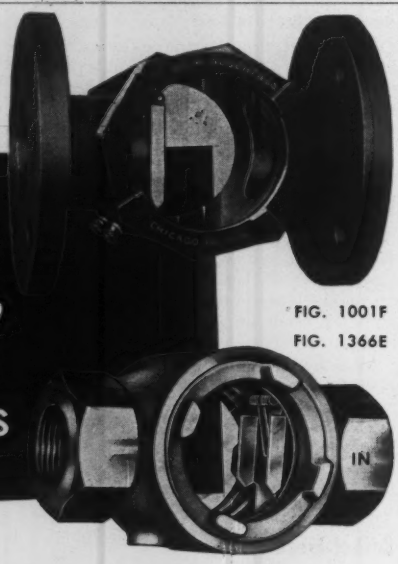
Tube Cutters

Two new tube cutters are included in the line of Parker tube-fabricating equipment manufactured by Parker Fittings & Hose Div., Parker Hannifin Corp. Both are rugged, adjustable cutting tools for producing clean, square ends on steel tubing as well as on the softer copper, brass, and aluminum tubing.

The Kloskut Model 216S, for tubing sizes from 1/8 through 1-in. OD, has rollers specially designed to permit cutting off flared ends of tubing close to the flare. The large Model 1232 cutter is for 3/4 through 2-in-OD tubing. Ask for Catalog Sheet 4394A5.

The cutters leave no external burr and have a handy retractable blade for burring the inside edge of the tubing. —K–48

How to SEE the "INSIDE STORY" on your pipe lines



Do you have pipe lines through which constant flow is a critical factor? Could slowdown or stoppage cause untold damage to valuable equipment? If it's important that you know what's going on inside a pipe line . . . Nugent Sight Flow Fittings can be one of the most economical investments you've ever made.

These fittings have large double windows to aid visibility. A spring compensated, hinged, indicator gate moves in proportion to the flow and is visible from either side, even when liquid is dark or discolored. Fittings available with electrical contacts to operate a bell or light should liquid flow cease. Sizes 3/8" to 6" inclusive . . . in brass, cast iron, and steel. Tapped or flanged.

Complete data upon request.

ESTABLISHED 1897

WM. W. NUGENT & CO., INC.

3412 CLEVELAND STREET, SKOKIE, ILLINOIS

REPRESENTATIVES IN PRINCIPAL CITIES

OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

BUSINESS NOTES

Research Center

Research laboratories, housed in a newly-constructed $1/2-million building with more than 13,000 sq ft of floor space, are in operation at Purolator Products, Inc.

The new Research Center will be devoted to pure research and new product development with provisions for pilot production. The company's major products are filters and filtration equipment.

New Sales Divisions

New Western and Midwestern sales divisions have been created by Snap-Tite, Inc. producer of quick-connect valved couplings. The Western Division will have headquarters at 16611 Ventura Blvd., Encino, Calif. Midwestern Division headquarters will be at 150 Meadowhill Lane, Chagrin Falls, Ohio, near Clevland. These supplement the Eastern Division with headquarters at Manchester, Md.

Underwater Laboratory

A laboratory facility to develop underwater nuclear fuel-element handling techniques and devices has been completed by Allis-Chalmers Mfg. Co. Located at the firm's Greendale, Wis., Laboratories, the facility consists of an 11-ft-diam by 40-ft-high tank containing 30,000 gal of reactor-grade demineralized water and a full scale mock-up of one-eighth of the reactor core for the Pathfinder Atomic Power Plant.

District Office

Western Gear Corp. announces the opening of an Industrial Products Div. District office at 3109 Mayfield Road, Cleveland, Ohio. The territory covered includes parts of New York, Pennsylvania, West Virginia, Michigan, Indiana, and all of Ohio and Kentucky.

The division designs and builds a complete line of mechanical-power-transmission products including gearmotors, speed reducers, high-speed units, and right-angle pump drives. It also produces custom-engineered products such as pinion stands, rolling-mill drives, and other special machinery to meet customer specifications.

Jet-Driven Gas Turbine

An eight-page brochure, describing the concept and operating characteristics of the 10,500-hp, RT-248 gas turbine, has been published by the Cooper-Bessemer Corp. The gas-generator section is built by Pratt & Whitney Aircraft and based on the J-57 jet engine.

Development of this new power concept is reviewed, and thermal efficiencies, maintenance costs, and potential applications are discussed. —K-49

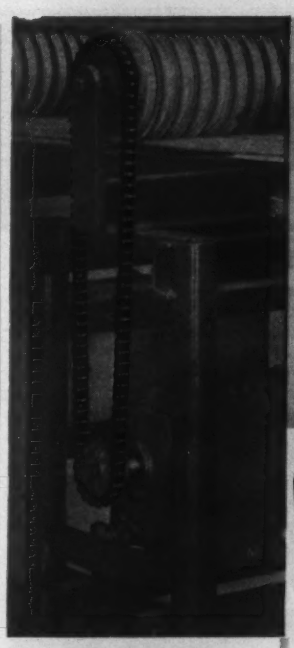
Manometers

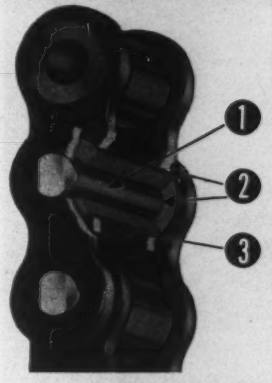
King Engineering Corp. announces 24-page Catalog 2008 on manometers for measuring pressure and vacuum in plants and laboratories. Descriptions and specifications are given on U-type, well-type (single and multi-tube) and inclined-tube manometers, manometer indicating liquids, and accessory equipment. —K-50

Electronic Weighing

"Industrial Weighing Through Electronics" has been reprinted by Streeter-Amet Co. The 12-page booklet explains, in layman's language, the history and development of electronic weighing, the theory of operation, instrumentation, economic considerations, and general data.

An accompanying six-page brochure, entitled "The Way to Weigh," describes weight-recording equipment and applications. —K-51





Built-in Lubrication at these 3 Critical Areas

Critical Area 1:

PIN—Protective oil film lubricates live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.

Critical Area 2:

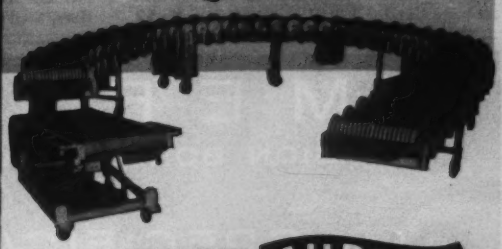
PLATES—Oil-impregnated Sintered Steel Bushings extend beyond surface of inside plates to: act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.

Critical Area 3:

SPROCKET ENGAGEMENT—Oil film on MSL Bushing exterior provides constant lubrication between sprocket teeth and chain. Whitney MSL Chain requires no rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

WHITNEY MSL* SELF-LUBRICATING CHAIN

Keeps Loads Rolling



For POWER-CURVE'S CONVEYORS

Power Curve's Bag and Package Loader works like a mechanical stevedore in high speed loading of box cars and trucks. The chain drives which shuttle and power this flexible conveyor must have plenty of stamina to withstand continuous shock loads from delivering chutes, and to propel loads in and out of cars.

To provide greater drive chain durability, Power-Curve engineers rely exclusively on Whitney MSL Self-Lubricating Chain.

The basic problem in chain operation has always been that more damage is caused by faulty chain lubrication at the 3 critical areas, than by years of normal service. Whitney Research has solved this problem through the development of a lubricated-for-life chain that outlasts ordinary chain as much as 5 to 1.

Oil-impregnated, Sintered Steel Bushings release a constant supply of lubricant under pressure and heat . . . re-absorb the oil when the drive stops . . . insure a permanent oil supply for the life of the chain.

For exceptional drive chain performance, long life, and for sure resistance to dust, dirt and other abrasives, specify and use Whitney MSL Chain. All essential dimensions conform fully to ASA Standards for complete interchangeability with any similar pitch chain.

Your Whitney Chain Distributor has a complete stock on hand, ready for immediate delivery. Consult him today.

*Maximum Service Life

THE WHITNEY CHAIN COMPANY

a subsidiary of FOOTE BROS. GEAR AND MACHINE CORPORATION

4539 S. Western Blvd., Chicago 9, Ill.

POWER TRANSMISSION DRIVES

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Painting Equipment

Airless paint-spraying equipment, paint heaters, hot-spray equipment, and standard-package installations for painting, manufactured by the DeVilbiss Co., are described in six-page Catalog I-3601. —K-52

Packaged Boilers

Powermaster Model 5 packaged automatic boiler made by Orr & Sembower, Inc., are described in a four-page bulletin. The line includes h-p and l-p types in 20 to 100-hp sizes, fired by oil, gas, and combination gas-oil. Hot-water units especially designed for forced-circulation heating applications. —K-53

AMERICAN
PRECISION BORED & HONED PARTS
TO SPECIFICATIONS

American has produced hundreds of power cylinders to most exacting specifications. Our deep boring and honing techniques have kept pace with the precision internal surfaces needed in the application of air and hydraulic cylinders. Whatever the basic material required, we have the tooling equipment and know-how to produce cylinders up to 16 inches I.D. and to 40 feet lengths.

We are equipped to supply American cylinders bored, honed, flanged, padded and externally machined to your specifications.

AMERICAN HOLLOW BORING CO.

You can depend on American as a reliable source for precision bored and honed parts for your most exacting applications.

1058 West 20th Street • ERIE, PENNA.

Wall Deslagger

The Vulcan RW-3A wall deslagger with fueal-air drive for fast, thorough cleaning of boiler, superheater, and reheat-section walls is described in Bulletin 1066 released by Copes-Vulcan Div., Blaw-Knox Co. There is an interesting explanation of how blowing air or steam is saved by extending and retracting the nozzle almost instantly, and how cleaning is thorough because of slow nozzle rotation. —K-54

Special Equipment Facilities

The company's qualifications for the fabricating and machining of large, unusual or difficult pieces of machinery and equipment are outlined in a four-page bulletin, No. 245, issued by Dravo Corp. entitled "Facilities and Services for Special Equipment." It cites outstanding fabricating jobs completed at the company's Neville Island plant, including the carriage for a 280-mm atomic cannon, aluminum wing sections for jet aircraft, wind-tunnel sections, large sinter-plant components and specialized equipment for the chemical industry. —K-55

Heat Treating

Nonferrous-metal heat treating, and the application of prepared gas atmospheres; flexible job-shop equipment; and an installation of 48 steel-mill soaking pits which will average 750 tons of ingots per hr are the topics of articles in the Heat Treat Review, Vol. 11, No. 1 published by the Surface Combustion Div. Midland-Ross Corp. —K-56

Pump Motors

Wagner Electric Corp.'s Bulletin MU-244 describes doubly-protected, dripproof, and totally-enclosed polyphase squirrel-cage motors, 1 hp and larger, with NEMA-C faceplates for close-coupled centrifugal-pump applications. —K-57

Toggle Clamps

Three models of plunger-type toggle clamps recently added to the standard line of De-Sta-Co clamps are described in Bulletin No. 601606 issued by Detroit Stamping Co. Model 601 is described and Model 601-0 is a small-clamp series with a 95-lb holding pressure. Model 606 is a medium-duty clamp with a rated holding pressure of 450-lb that features a narrow base, swivelling handle and linkage that rotates 180 deg for use in confined areas. —K-58

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Instrument Bearings

High-precision thin-width instrument bearings, designed for use in synchros, gear trains, potentiometers, servos, and small motors, are described in Bulletin 6002 issued by Miniature Precision Bearings, Inc.

Made to ABEC class-7 tolerances, ODs of the nine bearings range from 0.2750 to 0.5000 in. and bores from 0.0937 to 0.1875 in. They have the same levels of low torque and the smooth running characteristics of other MPB bearings and are available without premium charge. —K-59

Permanent-Magnet Pulleys

Useful data and specifications on the complete line of Indox V permanent-magnet pulleys in sizes from 12 to 48 in. in diam are included in Bulletin 1022 issued by Stearns Magnetic Products.

The pulleys, used in many industries for tramp-iron removal, separation, and cobbing operations, are made of Indox V, a highly oriented barium-ferrite ceramic magnet material claimed to equal the most powerful electromagnetic types in performance at much lower cost. —K-60

Eddystone Feedwater

Technical Reprint T-178, "Research Problems Relating to Production and Quality Control of Ultrapure Feedwater for Eddystone Station," is available from Graver Water Conditioning Co.

The paper presents the results of the investigations undertaken as part of the Eddystone research program into production and quality control of ultrapure condensate feedwater for Eddystone Station. Pilot plant data are presented on the filtration and demineralization process for treating condensate and specific plant-scale design features based on the data are described. —K-61

Filter Media

Information on various filter media for process fluids, nuclear applications, internal-combustion engines, hydraulic fluids, machine-tool coolants, bulk-fuel, and many other applications are included in an 18-page booklet, IND-1-60, issued by Purolator Products, Inc.

Explanations are provided of flow rate, degree of filtration, viscosity of fluids, and reliability for such filtration media as Micronic paper, metal-edge, wire-cloth, porous-metal media, plus oil-absorption and water-separation filters, and specially-designed filtration units for high and low temperatures (−420 to +1200F), high pressure, and corrosive gases and fluids. —K-62

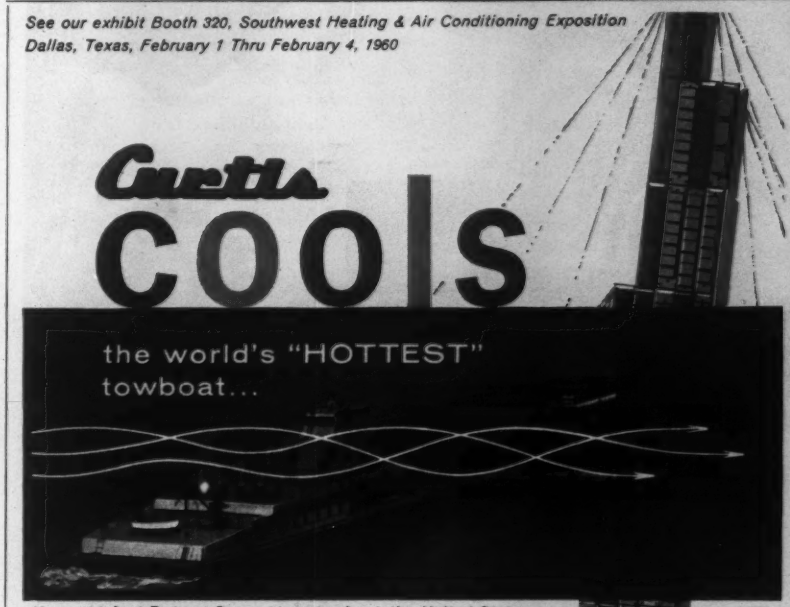
Submersible Pumps

The firm's newest F-series submersible pumps are the topic of a four-page bulletin released by the Deming Co. for dealer and distributor use.

Many internal parts of the new Deming Submersible are now made of Fianite, a thermosetting, glass-filled polyester which is unaffected by well water and resists abrasion and corrosion. The extremely smooth and pitless surface of Fianite permits higher ratings with the same horsepower. —K-63

See our exhibit Booth 320, Southwest Heating & Air Conditioning Exposition Dallas, Texas, February 1 Thru February 4, 1960

Curtis cools

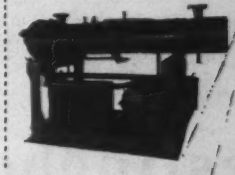


Huge 180 foot Federal Barge Lines towboat, the United States, has 50% greater horsepower than the largest towboat on the rivers. It can push 40 barges, totaling 1/3 mile, or 300 ft. longer than the "Queen Elizabeth".

C-103

Space saving design versatility? Easy installation? Operating dependability? Comparative cost? All these factors were considered by St. Louis Shipbuilding and Steel Company in the selection of air conditioning equipment for the world's most powerful towboat. The shipbuilders' and their design engineers' careful choice? A Curtis 20-ton packaged liquid chiller system. This equipment will cool the crew's quarters, galley, mess room, officers' and guest quarters—all with individual room or area temperature control.

The Curtis complete line, and reputation for dependability in installation of all types, work to the benefit of engineers and mechanical contractors. Factory run-in of all units cuts call backs far below average. You can safely promise dependable performance always up to, and frequently surpassing, rated capacity. You eliminate your problems when you specify Curtis, because you're working with an outstanding manufacturer of air conditioning equipment.

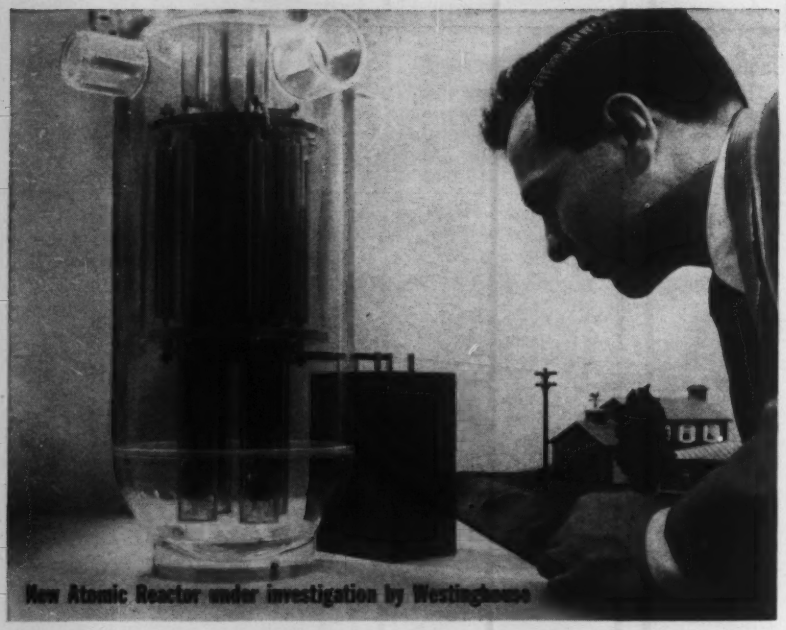


THE COMPLETE LINE OF LIQUID CHILLERS • PACKAGED AIR CONDITIONERS • CONDENSING UNITS

Curtis *ESTABLISHED IN 1854*

MANUFACTURING COMPANY • REFRIGERATION DIVISION • *St. Louis 33, Missouri*

NEW PROFESSIONAL GROWTH OPPORTUNITIES for PHYSICISTS, SCIENTISTS, ENGINEERS, (Metallurgical, Chem., Mech.)



New Atomic Reactor under investigation by Westinghouse

THE SEEBECK EFFECT—Utilizing the Seebeck Effect in a reactor environment, for direct conversion of heat to electrical energy, is one of the many research problems under intensive investigation at the Atomic Power Department of Westinghouse where scientists and engineers are seeking new and improved ways of developing economically competitive atomic power plants.

Scientist-Engineer—For design and application of digital and logical techniques for process measurement and control. B.S. with minimum 5 years related experience.

Scientist-Engineers—To work on irradiation damage studies of thermoelectric materials and instrumentation for measurement of thermoelectric parameters at high temperatures. Graduate degree in physics or metallurgy.

Scientist-Engineers—To design, fabricate and test experimental equipment for irradiation testing of materials. B.S., M.E., and experience applicable to position.

Scientist-Engineers—Nuclear systems design studies and calculations background required to establish primary coolant systems design and parameters i.e., temperature, pressures and flow rates. B.S., M.E. and 5 years experience in power plant design and cycle analysis.

If you can visualize your professional growth in an atmosphere of scientific investigation, write to: Mr. C. S. Southard, Westinghouse Atomic Power Division, P.O. Box 355, Dept. W-98, Pittsburgh 30, Pa.

Westinghouse

ATOMIC POWER DIVISION

FIRST IN ATOMIC POWER

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Bearings and Bushings

Bearings, bushings, bar stock, and babbitt metal are the topics of a 16-page American Crucible Products Co. brochure which includes formulas for running clearances, characteristics of effective lubrication, and pictures of the various types of oil grooving. In addition to describing Promet alloys, six pages are devoted to specifications, chemical composition, and mechanical properties of brass and bronze casting alloys and manganese and aluminum-bronze alloys.—K–64

Insulating Materials

The first catalog published since the merger of Baldwin-Hill Co. with Ehret Magnesia Mfg. Corp. to form Baldwin-Ehret-Hill, Inc., contains the new corporation's full line of over 30 industrial insulations. Properties and specifications of the complete line of heat and cold insulations for service from sub-zero up to 1900 F are presented.

Spun mineral wool, calcium silicate, and 85 per cent magnesia products in block, blanket, felt, fill, cement, and pipe-insulation forms are fully described and illustrated in the 24-page booklet. —K–65

Nonferrous Specifications

A detailed chart showing comparative specifications, chemical analyses, and minimum physical properties of Shenango Furnace Co. nonferrous alloys is available, from the Centrifugally Cast Products Div. In addition, Bulletin No. 157 describes component parts and assemblies regularly produced by the centrifugal method. —K–66

Switch-Circuit Assemblies

The 1PB700 series of compactly designed switch-circuit assemblies for use in pulse and digital systems, manufactured by Micro Switch, a div. of Minneapolis-Honeywell Regulator Co. is described in a four-page data sheet. A single square-wave output pulse is produced in synchronism with an external clock pulse with each operation of the pushbutton. Switches can be used with clock-pulse frequencies form 4 to 500 kc. The compact design saves engineering time required to develop flip-flop and gating networks for synchronizing one-shot circuits. —K–67

Couplings

Dihedral couplings, gear-type couplings that are designed to handle shaft misalignments up to 7 deg plus for various applications without loss of horsepower are listed in eight-page Catalog 69 issued by Ajax Flexible Coupling Co. Rubber-cushioned sleeve-bearing flexible couplings also made by Ajax Flexible Coupling Co., are listed in 12-page Catalog 68. —K–68

KEEP INFORMED

BUSINESS NOTES
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Limit Switch

Snap-Lock Limit Switch SL-2 is described in 16-page Bulletin EC-SL260. Key design features of the National Acme Co. product, an extensive section on how it works, switch specifications, parts lists, actuating cams, and operating levers are included on both the rotary action and the maintained-contact models. —K–69

Fluid Couplings

Twin Disc fluid couplings are covered in Bulletin 144-E, newly issued by Twin Disc Clutch Co. The line consists of small cast-aluminum couplings, 7.4 to 10.6, and large stamped steel units, 12.2 to 27. Horsepower range is 3/4 to 850 hp.

Basic couplings are covered as well as "package" units with a wide variety of input-output combinations for consumer use. A comprehensive discussion of fluid-coupling performance characteristics with both internal-combustion engines and electric motors is also included. —K–70

Air Compressors

The Clark Bros. Co. line of balanced opposed air compressors for standard 110-psi industrial applications is described in Bulletin 185. Specifications cover the complete line of 23 models (including units for soot blowing). Strokes range from 6 to 17 in. and sizes from 75 to 2000 bhp. —K–71

Machinery Mounts

"Practical Considerations when Installing Machinery" is the title of Bulletin 60–04 issued by Barry Controls Inc. Mounts which isolate shock and vibration but are installed without special foundations, drilling, or grouting are available for a wide variety of machines. Engineers are on call for recommendations, installation, and service. —K–72

Hidden Water Costs

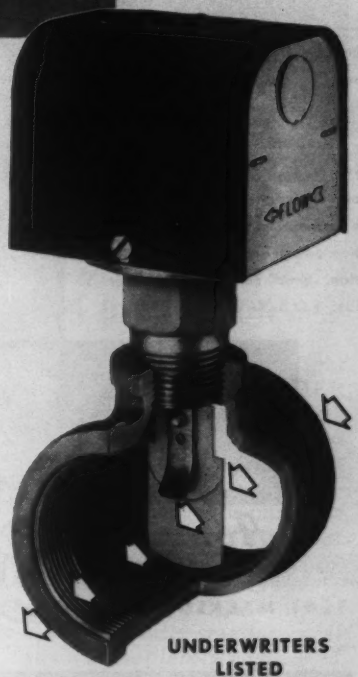
Leslie Co. has completed a new bulletin, No. 553-A, on liquid pressure-reducing valves titled "Eliminate Water Waste With Controlled Pressure." Ways that proper valve selection and application can reduce "hidden costs" of water used in industry are pointed out, emphasizing proper pressure regulation.

Operation of water reducing valves and proper sizing procedures are described. —K–73

Use a CLASSIFIED ADVERTISEMENT
for Quick Results

McDONNELL *Flow Switches*

FS4 Series Flow Switch shown mounted in a 2 inch Tee

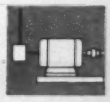


Here's what they do!

What you see here is a compact, well-built switch that makes or breaks a circuit (as required) when liquid flows or stops flowing. It's an economical and positive way to start or stop anything electrically operated. Just to highlight a few uses:

to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.

to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops.

to start or stop automatic burners—start a booster heater when water draw occurs, stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.

to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

UNDERWRITERS LISTED

Positive snap action switch. Easy to install and wire. Segmented paddle fits any pipe from 1" through 3". Unit shown handles pressures to 100 psi, temperatures to 300° F., in these types:

FS4-3—SPDT switch. Opens and closes two separate circuits with flow; closes and opens same two circuits with no flow.

FS4—Closes with flow; opens with no flow.

FS4R—Opens with flow; closes with no flow.

NOTE: Model E-2 available for larger pipes, pressures to 150 psi.

McDONNELL & MILLER, *Inc.*
3510 N. Spaulding Ave., Chicago 18, Ill.
Doing One Thing Well

Coupon brings bulletin
—covering design, construction, electrical ratings, dimensions, typical applications.

Please send me a copy of Flow Switch Bulletin FS1–A.

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By_____

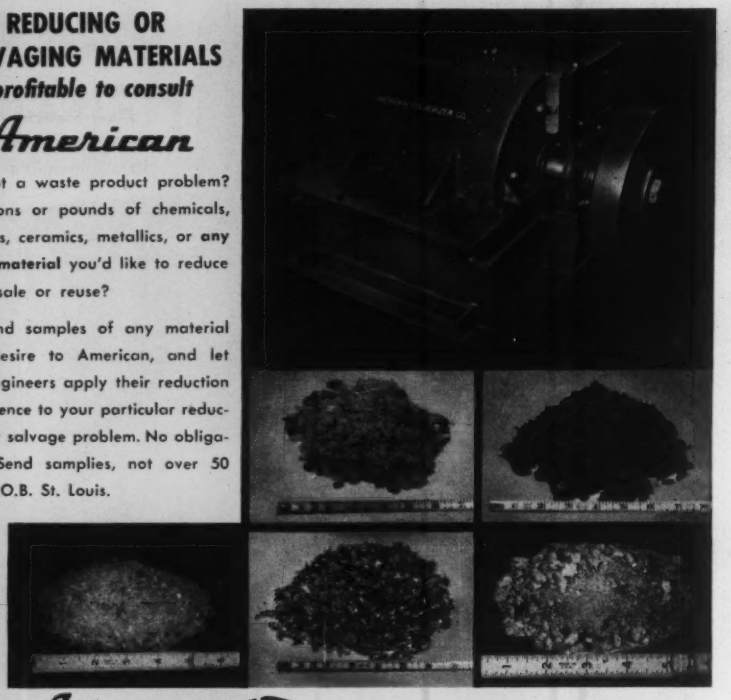
Mail to: McDonnell & Miller, Inc., 3510 N. Spaulding Ave., Chicago 18, Ill.

FOR REDUCING OR SALVAGING MATERIALS
it's profitable to consult

American

Got a waste product problem? Got tons or pounds of chemicals, plastics, ceramics, metallics, or any other material you'd like to reduce for resale or reuse?

Send samples of any material you desire to American, and let our engineers apply their reduction experience to your particular reduction or salvage problem. No obligation. Send samples, not over 50 lbs., F.O.B. St. Louis.



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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

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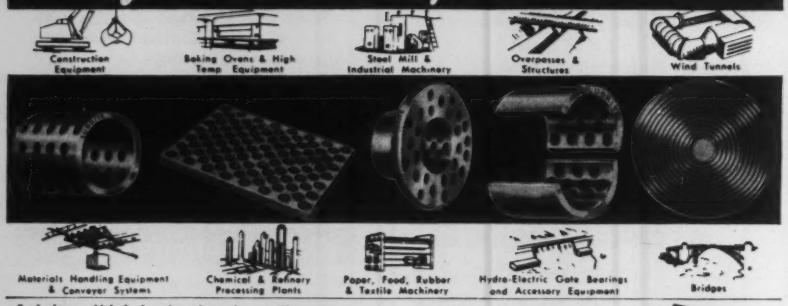
ASSURED **SELF-LUBRICATING SECURITY**
WITH **LUBRITE®**
Self-Lubricating **BEARINGS**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Lubrite self-lubricating bearings offer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

Lubrite Bearings, with clean, permanent, maintenance-free self-lubrication are designed to withstand severe loadings, temperature extremes, submersion, corrosion and other adverse conditions.

Lubrite may be just the bearing you need in your designs to obtain better results.

Consult our Engineering Department on your application. No obligation.

Send for this free 20-page Lubrite Manual No. 55—it contains complete information, technical data and specifications about Lubrite Self-Lubricating Expansion Plates and Bushings. Write today!

Available soon — New Manual No. 56 with complete technical information about LUBRITE SELF-LUBRICATING BUSHINGS, BEARINGS & WASHERS.

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189 AMORY STREET, BOSTON 30, MASSACHUSETTS

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Aircraft Locknuts

An aircraft locknut rated at 260,000-psi tensile strength is described in a four-page bulletin offered by Standard Pressed Steel Co. Called FN 26, the 12-point self-locking nut is described as the only mating locknut now available for 260,000 to 290,000-psi aircraft bolts.

Photos, charts, and line drawings point up design and performance features. **—K–74**

Pressure, Temperature Recorders

Temperature and pressure recorders made by the U. S. Gauge Div., American Machine and Metals, Inc., are described in Catalog 800.

Spiral bourdon tube and bellows-type pressure elements, their materials and performance characteristics are listed in the eight-page publication.

Temperature elements include: mercury, vapor-pressure, gas-pressure and organic-liquid types of actuation. **—K–75**

Gears

"An Advanced Concept in Modern Gears" is the title of a 12-page booklet offered by the Philadelphia Gear Corp., which fully describes the advantages is using hardened and precision-ground gears.

Various applications in radar-drive units, rotary-wing aircraft, high-speed gas-turbine drives, dredge cutter drives, marine propulsion, and others are illustrated and their advantages clearly discussed. **—K–76**

Vertical Wet-Pit Pumps

Ingersoll-Rand has a six-page flier featuring their line of vertical, wet-pit pumps for large-capacity pumping requirements up to 200,000 gpm. They are suitable for condenser circulating, drainage, irrigation, flood-control, sump-dewatering, and water-supply service in refineries and paper mills whenever large capacities must be handled at relatively low heads. **—K–77**

Water Generators

The full line of International-LaMont high-temperature water generators is described in 16-page Bulletin 1600 just published by International Boiler Wks. Co.

The LaMont principle of forced recirculation which permits temperature differentials to 200 F or more between generator outlet and return water for maximum system efficiency and economy is described. Flow-rate and heat-content tables, as well as considerations on choice of system pressurization and pump arrangement are included. **—K–78**

Time has brought decisive progress in the fight against cancer. Ten years ago one in four persons with cancer was saved. Today it's one in three. But time alone will not conquer cancer. Time plus research will. And research needs your dollars. Send your contribution today to "Cancer," c/o your local post office.

AMERICAN CANCER SOCIETY

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Motor Drive

An eight-page booklet, Bulletin GEA-7012, describes General Electric's new Parmatic speed variator, a compact packaged adjustable-speed d-c motor drive that operates from a-c power and is suitable for a wide variety of drive applications.

The new drive, featuring static power conversion, utilizes sealed silicon rectifiers and saturable reactors, is 25 per cent smaller, 50 per cent lighter, and has undergone extensive field testing. —K–79

Plastic Products

A 36-page catalog featuring plastic products of Teflon, Raylon, and Kel-F has been issued by Raybestos-Manhattan, Inc., Plastic Products Div. It illustrates and describes basic shapes available, as well as mechanical packings and gaskets; accessories for fluid handling equipment; custom-machined parts; thin-wall tubing; flexible wire-braided, aircraft, industrial, and rubber-covered hose; bondable Teflon and adhesives for bonding; O and back-up rings; bearings; and Teflon coatings. —K–80

Electrical Flow Meters

Remote-reading, electrical flow meters for all types of liquids and gases at line pressures to 5000 psi are described in Bulletin No. 59–5 issued by Republic Flow Meters Co., subsidiary of Rockwell Mfg., Co.

Principles and engineering features of the complete line of electrical remote-reading flow meters for steam, water, oil, and special liquids are described including typical electrical circuits, flow charts, piping and boiler arrangements and piping requirements for orifices, flow nozzles, and venturi tubes. —K–81

Valves

A completely revised edition of the Valves Condensed Catalog 10-A has been made available by the R-P&C Valve Div., American Chain & Cable Co. The 16 pages contain descriptions of the manufacturer's line of bronze, iron, and forged-steel gate valves; bronze and iron globe and angle valves; bronze and iron check valves; asbestos-packed iron cocks; bar-stock valves; valve parts; steel and forged valve accessories; and cast-steel valves. —K–82

Stainless Steel

A 12-page booklet issued by C. O. Carlson, Inc., describes the company's products and services. The company deals exclusively in stainless steels and is equipped to hanlde orders for the largest plate sizes and to meet specialized customer requirements. —K–83

Yoder Rotary Slitters reduce inventory... speed production

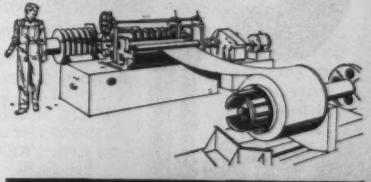
To help meet the demands of tight production schedules, YODER Slitters reduce mill-width stock quickly and economically to desired widths. If your needs are as low as 100 tons per month, time and manpower savings alone will offset the cost of your YODER Slitter in a matter of months, while reducing basic inventories. Compactly designed, standard YODER Slitters are built to handle standard coil widths... completely engineered lines for special requirements.

YODER accessories, such as coil cars, swivel unloaders, scrap choppers, scrap disposers, plate levelers and coil boxes, make stock handling fast and easy.

YODER also makes a complete line of Cold Roll-Forming equipment and Pipe and Tube Mills. To profit from YODER'S years of engineering and service experience, contact your local YODER representative or send for the YODER Slitter Manual.

Investigate the many advantages of YODER-engineered Slitter Installations. Write today for this comprehensive, 80 page YODER Slitter Manual... it's yours for the asking!

THE YODER COMPANY
5499 Walworth Avenue • Cleveland 1, Ohio



ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Gears

A four-page brochure issued by Ohio Gear Co. describes a complete line of stock and special gears designed to meet all industrial-power drive requirements. Both 14½ and 20-deg pressure-angle styles are included. Information on bevel, helical, miter, worm, and spur gears as well as steel racks is given. —K-84

Ceramic-Insulated Wire

AeroOpak ceramic insulated wire with compacted ceramic surrounding one or more conductors, all contained in a metallic sheath, is the topic of a booklet issued by Aero Research Instrument Co. Some inherent characteristics are high (3000-F) operating temperature and flexibility. It can be formed to a radius of the sheath diameter or weldments can be made on sheath without loss of insulation. AerOpak wire can be widely used in making complete thermocouple assemblies, insulated electrical conductors, and miniature heating elements with high watt dissipation. —K-85

Abrasive Compound

Carborundum's new folder on Carbo-Latex P5 describes a synthetic-latex abrasive compound for safety antiskid floors, stair treads, sidewalks, highways, and airstrips. Developed jointly by Carborundum and Firestone Tire & Rubber Co., it has excellent affinity to concrete, asphalt, sealed-wood, steel, and other foot and vehcile-traffic surfaces. —K-86

Heat-Transfer Units

The "Platecoil Technical Data Manual," Bulletin No. 159, of the Platecoil Div., Tranter Mfg., Inc., describes a group of heat-transfer units fabricated from two embossed metal sheets through which heating or cooling medium is circulated.

Flexible in design and light in weight, Platecoil units have numerous applications in industry for heat-transfer requirements such as open or closed tanks of all types together with other process vessels, ovens, heat screens, presses, and heat exchanges of various types. —K-87

Air Handling Equipment

A revised bulletin, No. B-5529, describes the complete line of American-Standard Industrial Div. products. The 24-page bulletin gives basic ratings for air-conditioning and air-handling equipment, fluid drives, heat exchangers, surface condensers, steel boilers, and related industrial products. —K-88

Instrumentation for Weighing

A condensed eight-page catalog issued by Streeter-Amet Co. lists a number of flexible components which may be used in various combinations to detect, record, and indicate different physical quantities. Other components perform automatic-control functions and transmit the information over long distances. Load-detection devices, recording-instrument accessories, telemetering system, circular and strip pen charts, analog-digital readout instruments, and control transformer instrumentation systems are among the major categories of equipment. —K-89

SPLIT-EYELET CONNECTORS

For faster, easier connection of spray nozzles, branch lines and equipment to piping and tubing carrying liquids, gases or air up to 250 psi. Write for Bulletin 93.

FOR BETTER PERFORMANCE

SPRAY NOZZLE ACCESSORIES

ADJUSTABLE JOINTS

For easy, exact adjustment of spray direction. Made in size for ¼" to 2½" pipe in brass, steel and stainless steel. Write for Bulletin 97.

...EASIER INSTALLATION

LINE STRAINERS

Special non-collapsing screen design for pressures up to 125 psi, for all pipe lines from ¼" to 6" size. Also high pressure strainers for up to 5,000 psi service. Write for Bulletin 94.

FOR COMPLETE SPRAY NOZZLE INFORMATION WRITE FOR CATALOG 24

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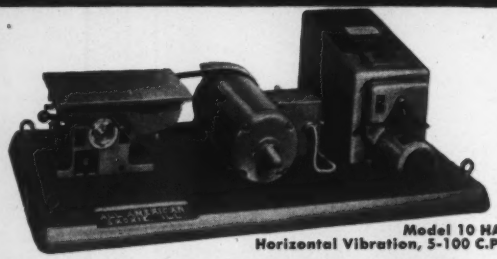
3265 RANDOLPH STREET • BELLWOOD, ILL.

ALL AMERICAN TESTERS
SPOT VIBRATION WEAK SPOTS BEFORE COSTLY FAILURE!



Model 10 HA-T
Horizontal Vibration, 5-100 C.P.S.

• How much vibration will your product take? Where are the danger areas? All American Vibration Fatigue Testers answer these questions in your shop or laboratory with shake-down tests that simulate field service vibrations. Engineering gets the facts needed to improve design at lowest cost. Equally effective in spot-checking production runs.

• All American Testers meet U.S. Government specifications for horizontal or vertical vibration testing of all sizes and shapes of units weighing up to 150 lbs. Range Selector automatically controls acceleration and deceleration, or holds vibration frequency at any desired point between 5 and 100 cycles per second.

CATALOG "F"
gives full facts on all 10 All American Testers, proved in long service to government and industry.
Write for your free copy now.

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Builders of ALL AMERICAN Precision Die Filing Machines
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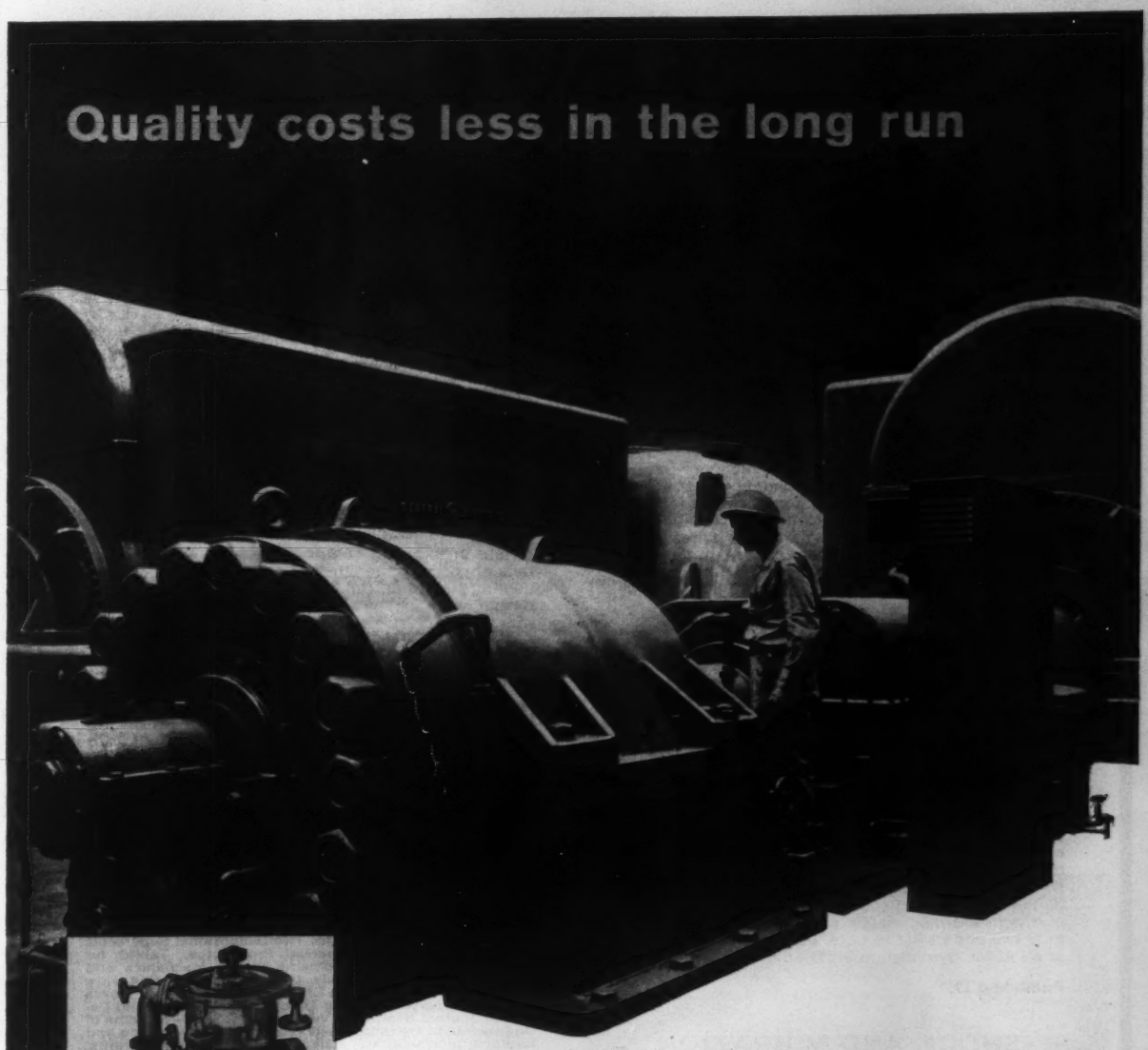
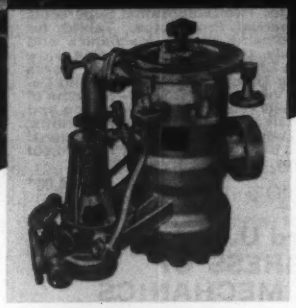
Quality costs less in the long run





"BLUE RIBBON" boiler feed pumps for every application . . .

Demands for higher pressures and capacities in modern boiler feed pumps have also created a need for higher speeds and greater reliability.

And in boiler feed pumps – as in every other type of centrifugal – Byron Jackson can match any requirement with a quality, performance-proved pump.

From direct turbine-generator driven models, such as the giant 12,000 horsepower, 3,600 rpm unit above, to the compact, 15,800 rpm marine boiler feed pump shown at the left, BJ designs are inherently reliable. Built-in balance, minimum NPSH requirements, and simple, effective sealing are common to all BJ Quality Pumps for the power industry.

Quality *does* cost less in the long run!

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subsidiary of Borg-Warner Corporation

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Since 1872

"Proved" Technical Aids for Engineers

MECHANICAL IMPEDANCE METHODS FOR MECHANICAL VIBRATIONS

A reference for engineers specializing in vibration analysis and control

This book shows how impedance methods apply to lumped and continuous systems of simple and moderate complexity, reviews measurement techniques, demonstrates the power of digital computers by comparing the calculated and measured characteristics of a highly symmetrical system of moderate complexity, gives measured values of typical structures of large size and high complexity, discusses the importance of the impedance in influencing shock and vibration spectra measured in field service, indicates how to apply impedance methods to the calculation of vibration isolator effectiveness, treats impedance of some disordered systems, shows how impedance methods may be used to find the response to random excitation, and describes a dynamic stiffness method that has proved useful in predicting critical speeds of steam turbines.

Published 1958 **$5.50***

THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASES, LIQUIDS, AND SOLIDS

A valuable and advanced survey of data and techniques on the thermal properties of important materials engineering

The methods and important experimental findings in this book are based on the work of the foremost authorities in the field. They include a survey of the present theoretical and experimental state of the science, a large amount of new data on current experimental and theoretical techniques, including thermodynamic and transport properties, PVT data and equation of state, some experimental transport properties, and high thermodynamic properties of gases. The forty-two papers in this book were originally presented at an ASME Symposium on Thermal Properties.

Published 1959 **$12.50***

SHOCK AND VIBRATION INSTRUMENTATION

Gives the principal results of research and development programs sponsored by various agencies

Random vibration, effect of nonrigid structures on vibration isolation, hysteresis and slip damping, vibration and shock testing, design approaches, and analog methods are some of the subjects covered. Emphasis is placed throughout on applicable basic principles rather than on explicit problems of only passing interest.

Contents: The Evaluation of Mounts Isolating Nonrigid Machines from Nonrigid Foundations. Experimental Study of the Effects of Foundation Resilience on Vibration Isolation. Effect of Material and Slip Damping on Resonance Behavior. Shock and Vibration Environments. Mechanical Design for Random Vibration and Shock. Influence of Electrical and Motional Impedance on the Control and Performance of Some Vibration Machines. Shock Testing Machines and Procedures. Damaging Potential of Shock and Vibration. High Speed Computing Methods for Shock and Vibration Problems.

Published 1956 **$5.00***

STRUCTURAL DAMPING

Provides a wealth of information useful in engineering design

This book discusses such structural damping techniques as interfacial coulomb slip, viscoelastic laminate damping, and coulomb or viscoelastic junction damping. The information has been written by authorities in the field.

Contents: Energy Dissipation Mechanisms in Structures, with Particular Reference to Material Damping. A Review of Progress in Analysis of Interfacial Slip Damping. Damping of Plate Flexural Vibrations by Means of Viscoelastic Laminae. Vibrational Energy Dissipation at Structural Support Junctions. Measurement of Damping. Material Design for Resonant Members. Selected Bibliography on Structural Damping.

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DESIGN DATA AND METHODS

Replete with data, procedures and solutions—all in a form most useful to design engineers

Here in forty-one contributions and 200 pages are data applying to the stresses and deflections of engineering structures, fluid mechanics problems, bearing design, vibration, and balancing.

Contents: Stresses and Deflections in Circular and Rectangular Plates. Circular Beams Loaded Normal to the Plane of Curvature. Rectangular Plate—Subjected to Hydrostatic Tension and to Uniformly Distributed Lateral Load. Design Data for Flat Circular Plates with Central Holes. Deflections and Moments for Rectangular Plates with Hydrostatic Loading. Critical Loads on Variable-Section Columns in the Elastic Range. Analysis of Elastic Two-and Three-Section Short Columns. Computation of Flexural-Torsional Buckling Loads. Data Sheets for Design of Piping. Expansion of Formulas for Calculating Loads, Rotation, and Deflections of Quarter Bends and Tangents of Pipes. Factors of Stress Concentration Photoelastically Determined. Factors of Stress Concentration for Slotted Bars in Tension and Bending. Torsional Stresses in Shafts Having Grooves or Fillets. Helical Compression and Tension Springs. Calculation of Rectangular Bar Helical Springs. Calculation of Stress in Crane Hooks. Thermal Stress. Stresses in Pressure Vessels. Design of Press- and Shrink-Fitted Assemblies. Working Stresses. Stress-Concentration Factors for Single Notch in Flat Bar in Pure and Central Bending. On the Maximum Numerical Value of the Tangential Stress in Thick-Walled Cylinders. Stresses in Curved Beams—A Tabular Method of Solution Based on Winkler's Theory. Method of Characteristics for Two-Dimensional Supersonic Flow—Graphical and Numerical Procedures. Tables for Numerical Solution of Problems in the Mechanics and Thermodynamics of Steady One-Dimensional Gas Flow Without Discontinuities. A Chart for Oblique Shock Waves in Water. Applying Bearing Theory to the Analysis and Design of Journal Bearings. Vibration Problems—Systems of One Degree of Freedom. Vibration Problems—Friction and Damping in Vibrations. Balancing of Rotating Apparatus. Harmonic Coefficients of Engine Torque Curves. Torsional Vibration Modes of Tapered Bars. Frequency of Vibration of Rectangular Isotropic Plates.

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Proceedings, 3rd U. S. NATIONAL CONGRESS OF APPLIED MECHANICS

Presents the findings of original researches and discusses the current approach to problems

Within this 904-page volume are reports of important studies in the fields of dynamics, vibration, elastic waves, elasticity, elastic structures, plasticity, viscoelastic flow, fracture, fluid flow, aerodynamics, and heat transfer. There are also discussions of new concepts and methods, and a large amount of new data which will aid in generating new ideas and new approaches toward solving other problems of the applied mechanics field.

Published 1958 $20.00 to members and nonmembers

***20% discount to ASME members.**

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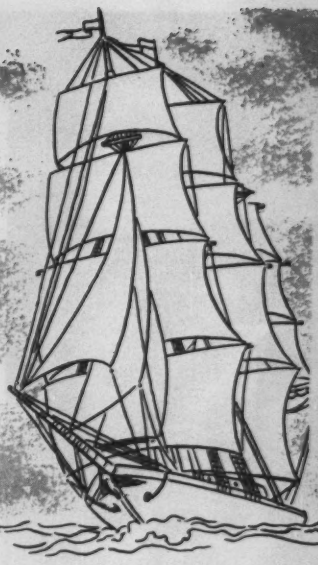
29 West 39th Street New York 18, N. Y.

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

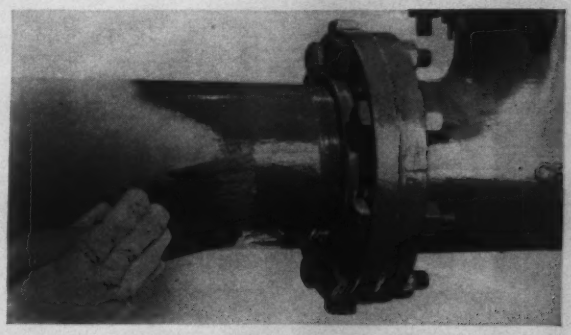
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



RUST-OLEUM®

There are imitations, but only *one* Rust-Oleum It is distinctive as your own fingerprint.

STOPS RUST!®

ATTACH TO YOUR LETTERHEAD

Rust-Oleum Corporation
2526 Oakton St., Evanston, Illinois

Please send me the following at no cost or obligation:

- ☐ New Color Horizons Systems Catalog featuring 110 actual color standards and 69 photo applications.
- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer to be applied over sound rusted surface.
- ☐ Results of radioactive tracing study on Rust-Oleum fish oil penetration.

Know it by the yellow handle

Use it because it embodies features never before combined in a needle throttling valve...

It is the first throttling and shut off valve that serves the whole range of pressures—from low to 10,000 psi—with equal efficiency all the way through.

It is the valve in which body and stem guide are one piece—completely fused into an integral leak-proof unit by the exclusive Marsh "Conoweld" process.

It is the valve in which the stem is precision machined and ground. Perfect stem alignment and fine threads provide easy and precise throttling. Special "Marpak" packing always holds tight; never binds.

Bodies of the 1900 series identified by the yellow handle are machined from high grade carbon steel bar stock marked in accordance with M.S.S. regulations showing size, material and service. Stems are 416 stainless steel. Valves are available in the patterns shown below; sizes ⅛", ¼", ⅜", ½", ¾" and 1".

Marsh Needle Valves are also available in 416 stainless steel throughout (identified by green handles). *Write for bulletins.*

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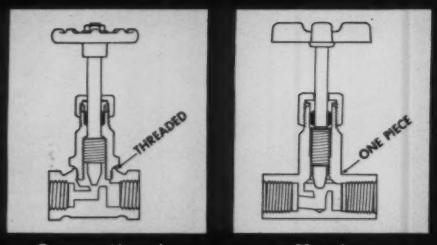
Division of Colorado Oil and Gas Corporation

Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

In stock at your nearest Supply House

WORKING PRESSURES UP TO 10,000 psi



Conventional Construction | **Marsh Construction**

In conventional valve (left) stem-guide is threaded into body . . . can be backed out when valve is fully opened, causing real trouble when pressure is high. Can't happen with Marsh design (right). Marsh stem-guide is welded to body.

MARSH

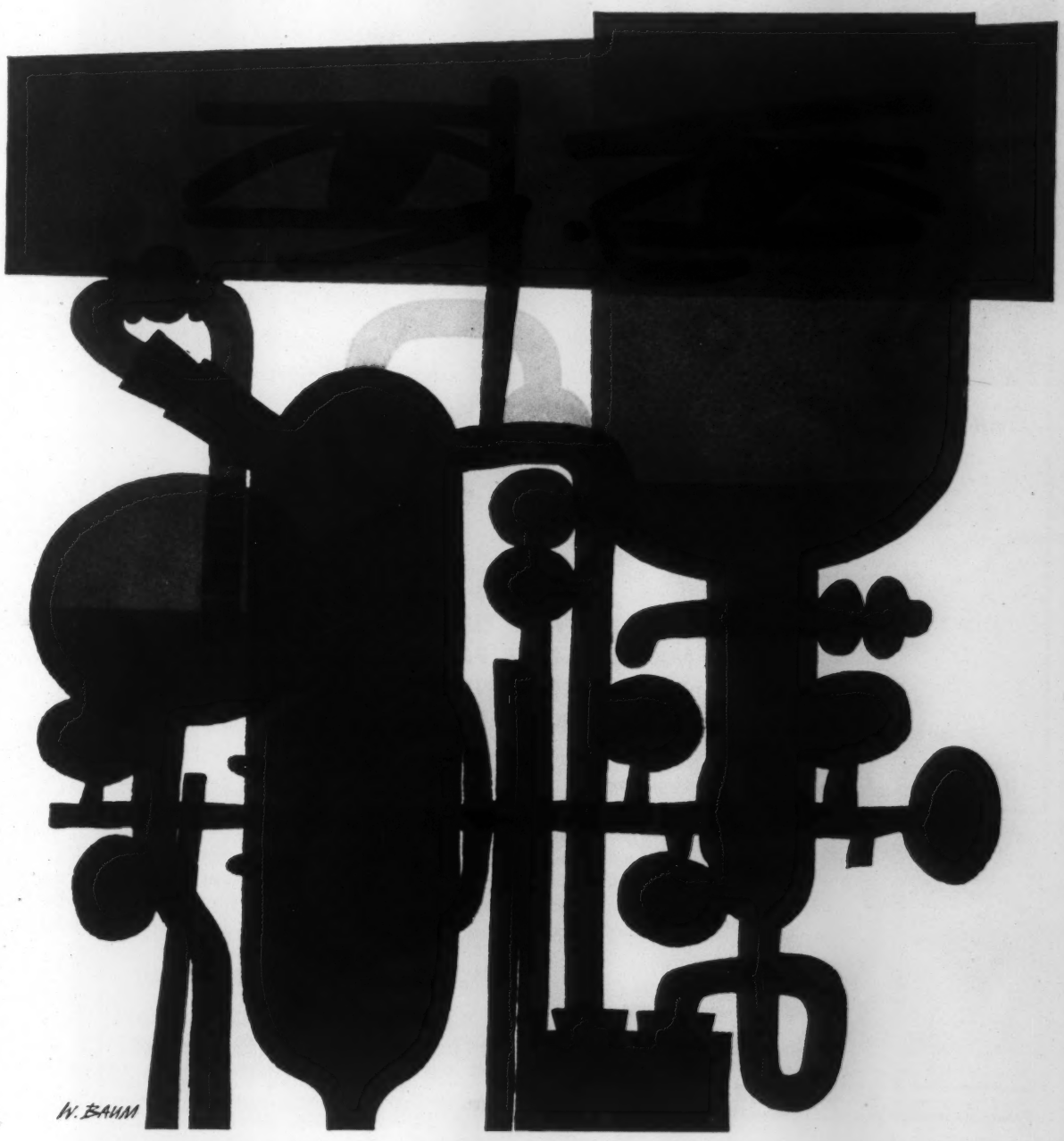
SERIES 1900

Needle Valves

FORECAST

Laboratories for space science at Martin are now studying and forecasting the physical, psychological, and biological factors that will affect man in space . . . another tremendously fascinating program which attracts persons with exceptional professional abilities. If you have these abilities, you are invited to communicate with N. M. Pagan, Director of Technical and Scientific Staffing (Dept. 2-D) The Martin Company, P. O. Box 179, Denver 1, Colorado.

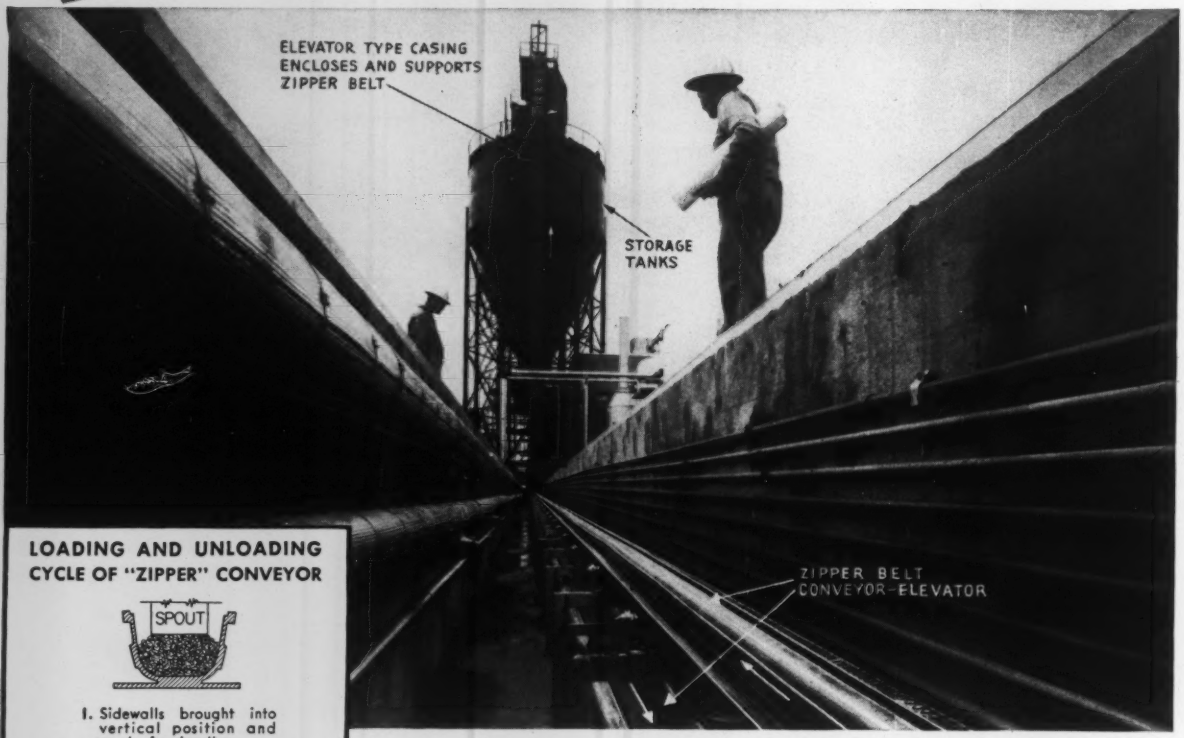
MARTIN
DENVER DIVISION



STEPHENS-ADAMSON

EXCLUSIVE

"ZIPPER"* CLOSED-BELT CONVEYOR-ELEVATORS

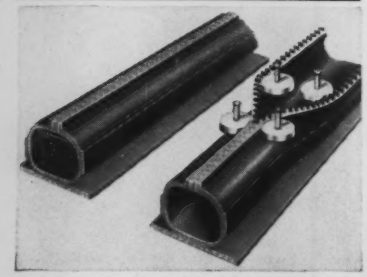


LOADING AND UNLOADING CYCLE OF "ZIPPER" CONVEYOR

1. Sidewalls brought into vertical position and ready for loading.

2. Flexible tube completely closed for conveying and elevating.

3. Rubber ZIPPER belt open for discharge, cleaning and return run.



Upper left unit closed and loaded. Lower right shows how belt is opened and closed by system of ball bearing rollers. (Rollers are mounted on a rigid framework)

CONVEYS AND ELEVATES BY CONTINUALLY WRAPPING MATERIAL IN A PACKAGE... MOVING THE PACKAGE AND ITS CONTENTS TO A NEW LOCATION AND GENTLY UNWRAPPING IT!

Literally a moving material-carrying conduit, the ZIPPER Conveyor is capable of transporting bulk materials in any plane, to considerable heights and around obstructions. Its great advantage is that bulk materials may be conveyed within the belt completely sealed and dust-tight. Material doesn't slide, isn't scooped, pushed or thrown but is gently carried over great distances without breakage, agitation or segregation. The ZIPPER Conveyor-Elevator provides versatility of layout and profitable material handling advantages you won't want to overlook.

*PATENTED

WRITE FOR BULLETIN 349

ENGINEERING DIVISION
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GENERAL OFFICE & MAIN PLANT, 19 RIDGEWAY AVENUE, AURORA, ILLINOIS

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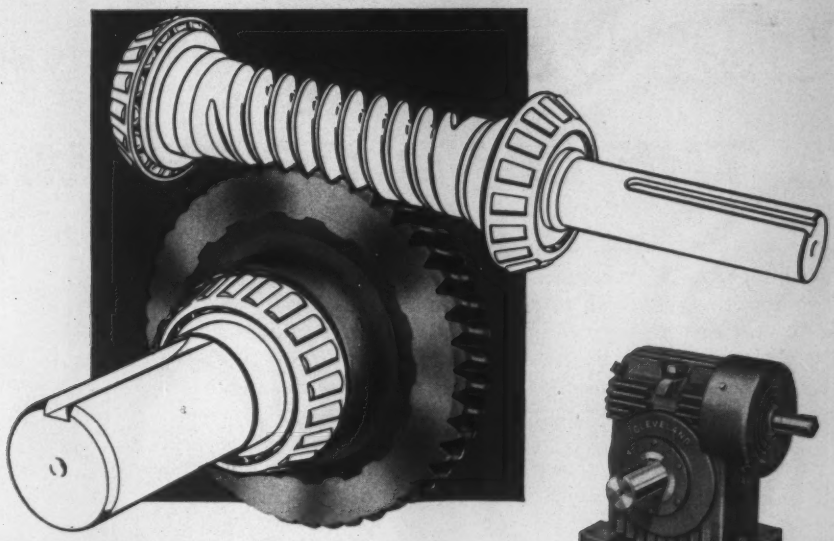
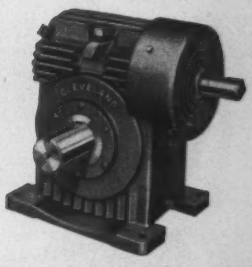




for longer trouble-free service life

...New Higher Horsepower Cleveland Speed Reducers feature centrifugally cast bronze gears

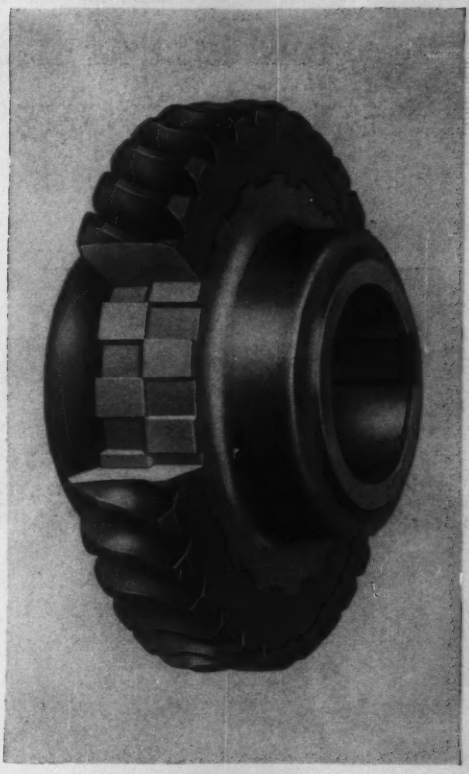
Providing higher input horsepower and output torque ratings, *New* Cleveland Speed Reducers now give industry dependable speed reduction at savings of 50% or more on per horsepower cost—without increasing size of the units.

Playing an important role in helping achieve these improved new ratings are Cleveland's centrifugally cast bronze gear rims of a high copper-tin-nickel alloy. When properly cast, this material provides highest strength compatible with requirements that it be free from abrasive crystalline components. Yet it's yielding enough to avoid excessive loading stress localization, while affording a low coefficient of friction against hardened steel—providing increased resistance to wear and fatigue pitting.

These rugged bronze rims are cast integrally with their supporting cast iron hubs (see photo at right). Checkered hub circumference holds the rim securely in position, making the two members independent of actual surface bond.

Also, another plus value of the New Cleveland Reducers is their especially large gear shaft diameters—which provide greatly increased overhung load carrying capacity.

For complete facts on this New Cleveland Speed Reducer Line, consult your local Cleveland Representative. Or, write us direct for free Bulletin No. 405—it gives *complete* engineering information for designers and engineers.



CLEVELAND
Speed Reducers

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3264 East 80th Street • Cleveland 4, Ohio

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Science has brought us to a unique vantage point from which we can foresee vast technological change. As the curve of scientific progress approaches the vertical, today's pioneers who wish to contribute significantly in their chosen fields will do well to consider the unequalled challenge offered by association with one of the nation's foremost scientific laboratories. Positions are currently available in physics, electronics, mathematics, and in mechanical and aeronautical engineering, as well as in other technical disciplines.*

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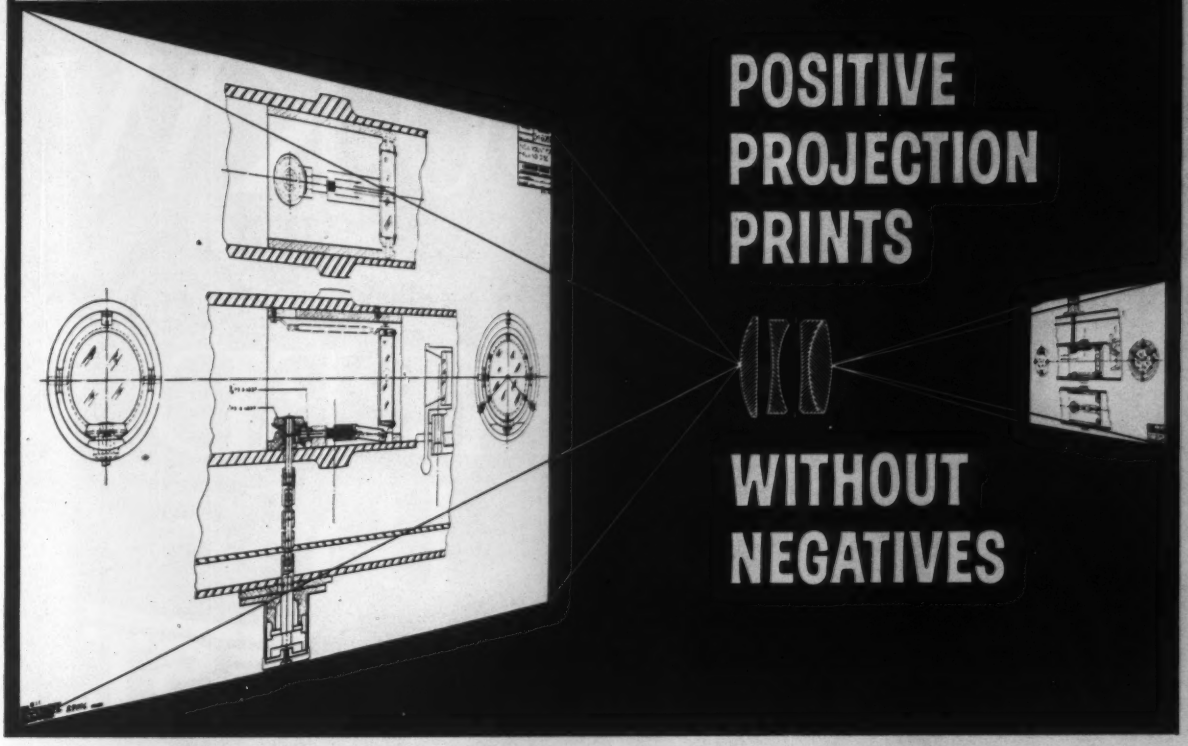
*These positions are in the Career Civil Service.

NEW FROM KODAK **Kodagraph Autopositive Projection Paper**



Here's an entirely new direct-positive camera-speed paper with special quick-processing, wash-off emulsion . . . no fixing required.

Now, with a *single* shot in camera or enlarger, you can make—on paper—high-contrast *positive* reductions or enlargements of positive originals . . . or you can make negatives from negatives. Develop in Kodagraph Autopositive Projection Developer (no fixing required), then rinse off emulsion and wash. *Specially suited* for making reduced-size intermediates of engineering drawings, or enlarged positive prints from microfilm positives. Also ideal for copying any document or art pasteup.

Available in two weights: *Extra Thin* for "intermediate" use in blueprint or whiteprint equipment, and *Standard* for general copying.

Plus these two favorites . . . now better than ever!

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Autopositive Paper, Translucent

Exposure speed is stepped up. Line sharpness is greatly increased, while background density is decreased—giving you intermediates which produce sharper, cleaner prints. Greater roomlight tolerance, especially to fluorescent light, makes printing and processing easier.

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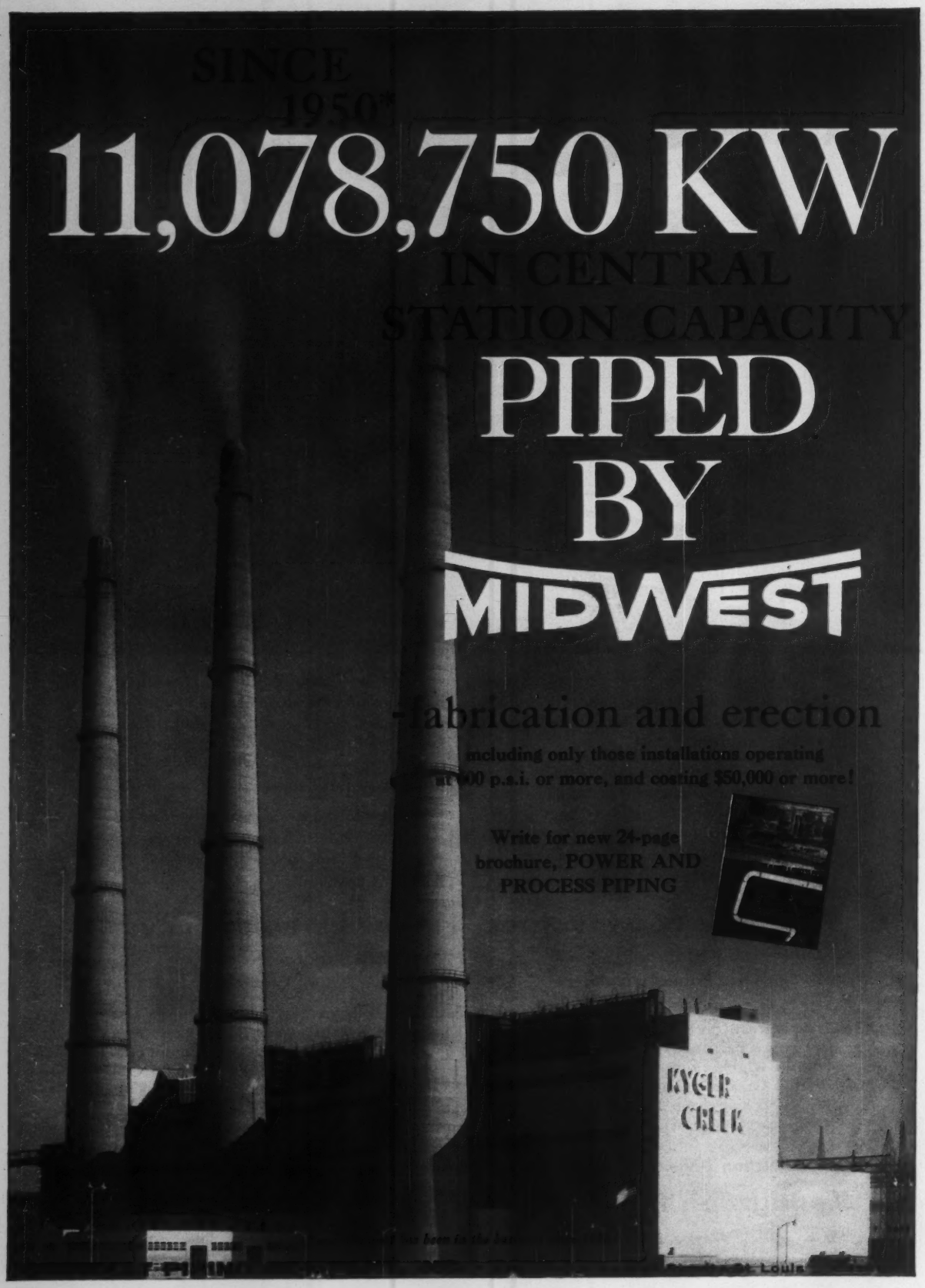
All the advantages found in new Autopositive Paper Translucent on an extra thin base. Gives you superb intermediates at a minimum cost. See for yourself how these NEW FROM KODAK reproduction materials make the job easier, better! Call your Kodak dealer or write: to Eastman Kodak Company.

Graphic Reproduction Division, Eastman Kodak Company, Rochester 4, N. Y.

Kodagraph Reproduction Materials

"Make the job easier . . . better!"

Kodak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11,078,750 KW
IN CENTRAL
STATION CAPACITY
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00 p.s.i. or more, and costing $50,000 or more!
Write for new 24-page
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An Opportunity To Sell Mechanical Engineers

Through a display at the Power Show more productive sales calls can be made—economically—than in any other manner. And these calls are made in a more relaxed atmosphere—no piled up desks, no jangling phones interrupting, no competing distractions.

The mechanical engineers (and others concerned with the various power services within their plants) visit the Power Show to see, discuss and compare the latest equipment for use in the generation, control, distribution and end utilization of all forms of power.

The engineers visiting this Exposition, from 49 states of the U. S. and 35 foreign countries, are the buying influences to whom your year 'round sales and advertising efforts are directed. Meeting them personally through a display at the Power Show will directly benefit your overall selling program.

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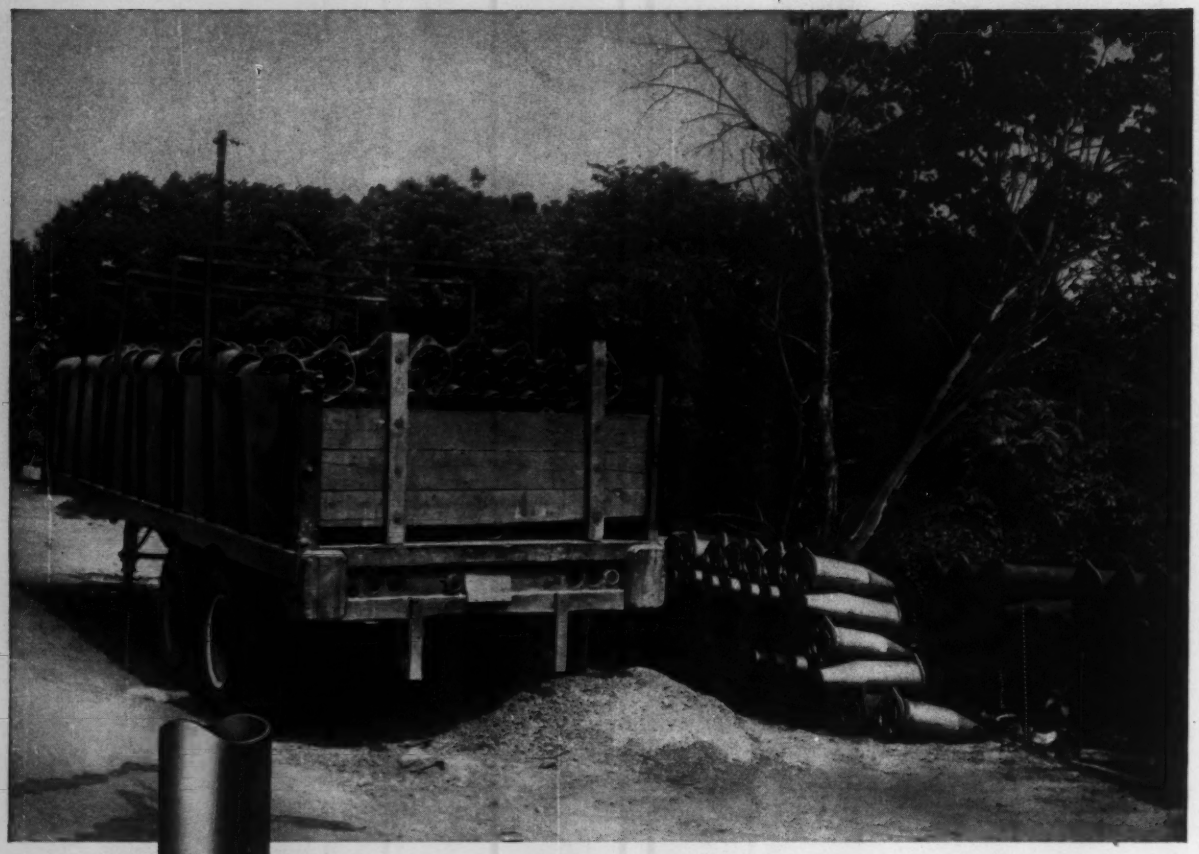

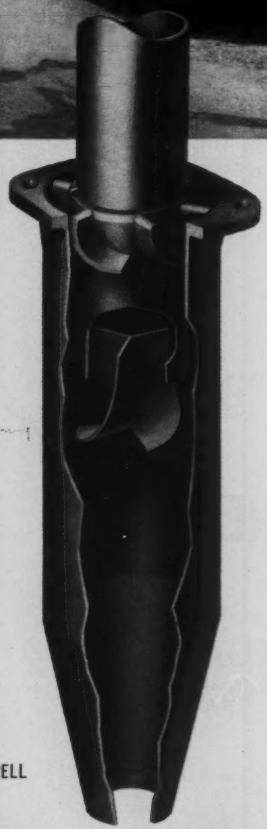

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38

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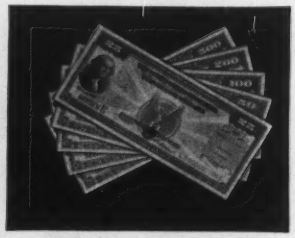

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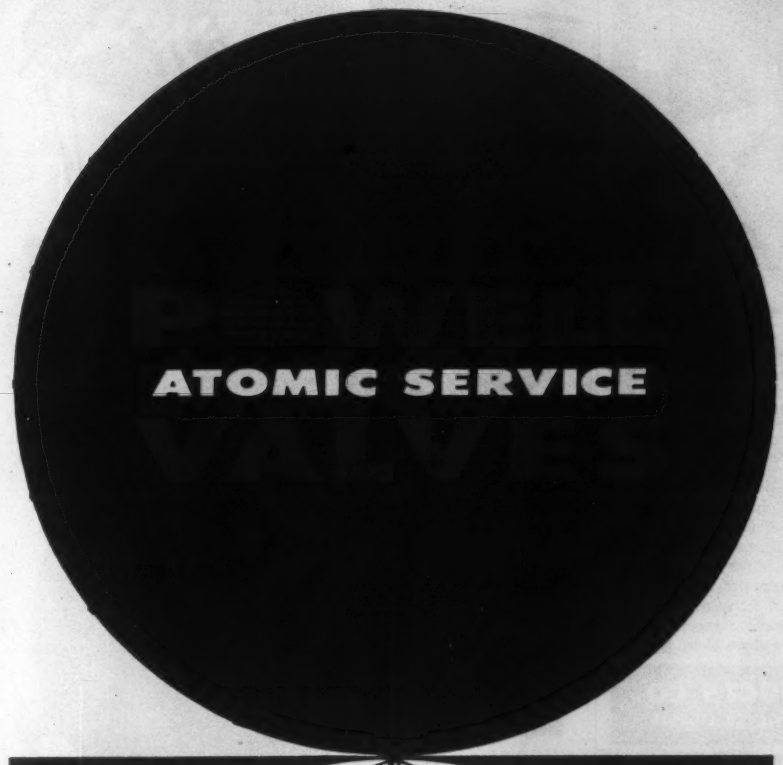

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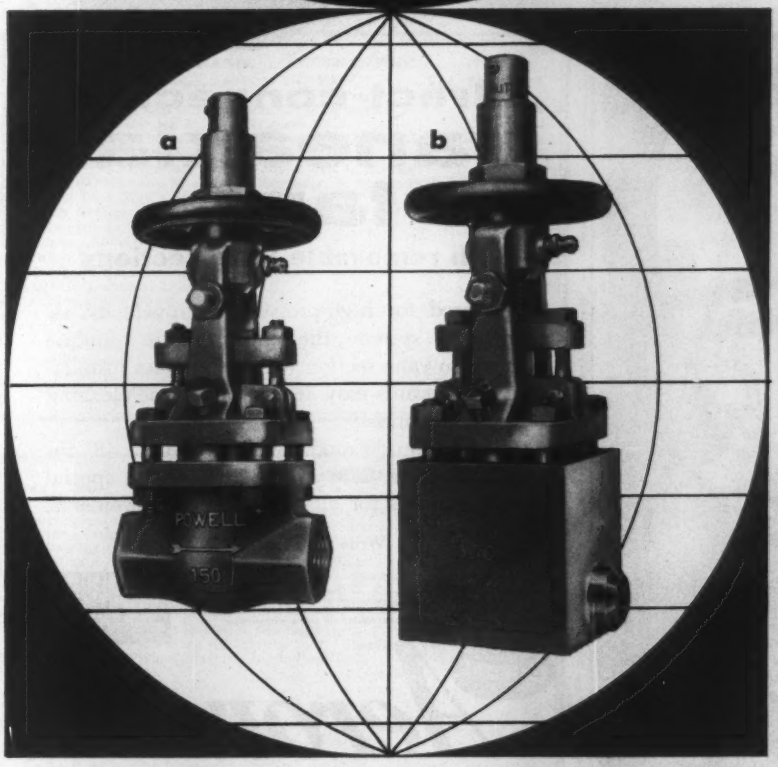

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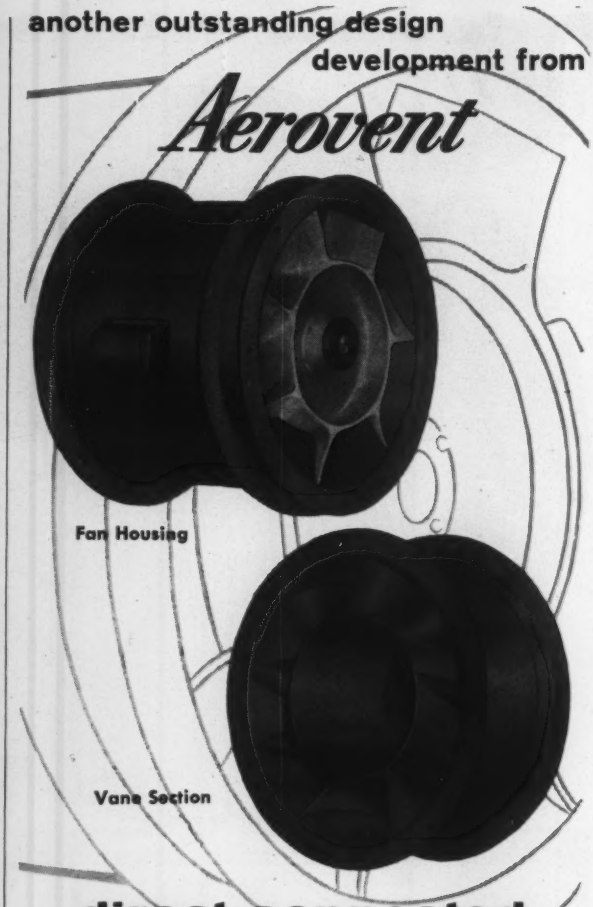

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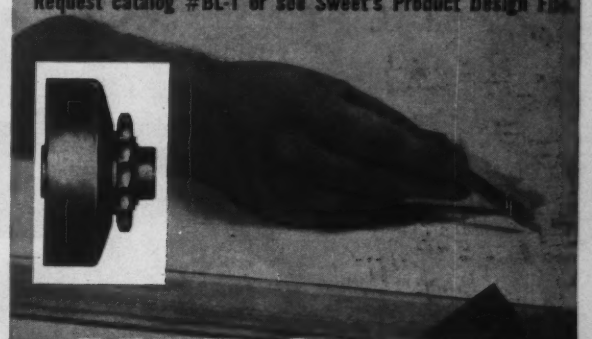

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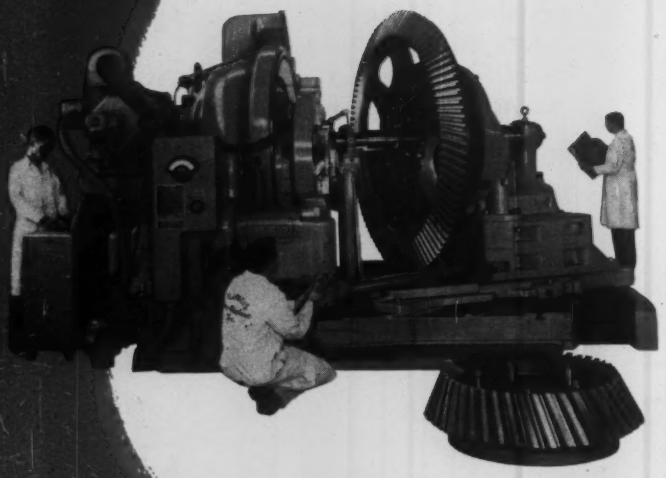

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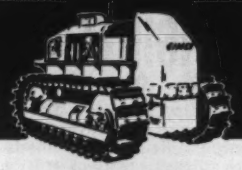

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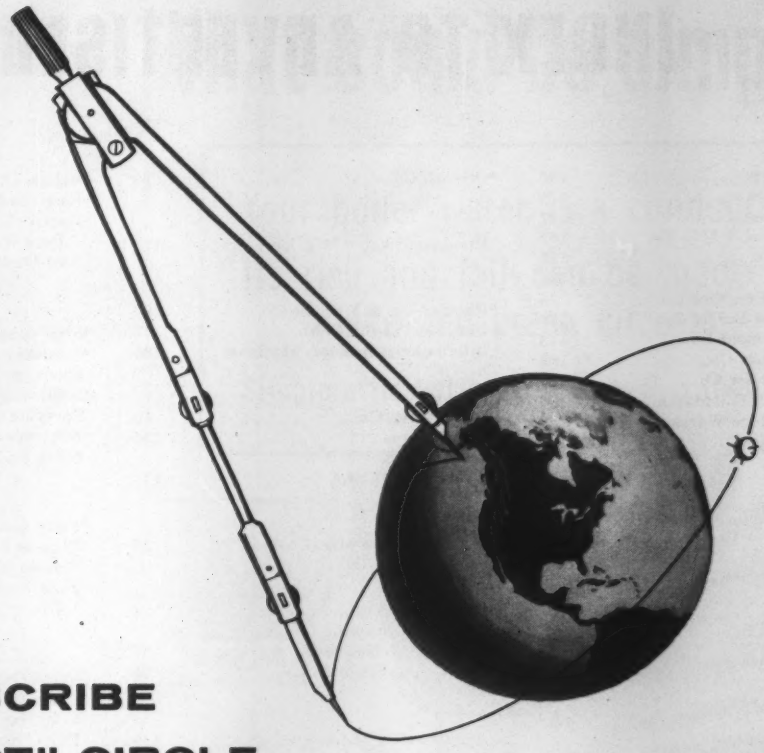

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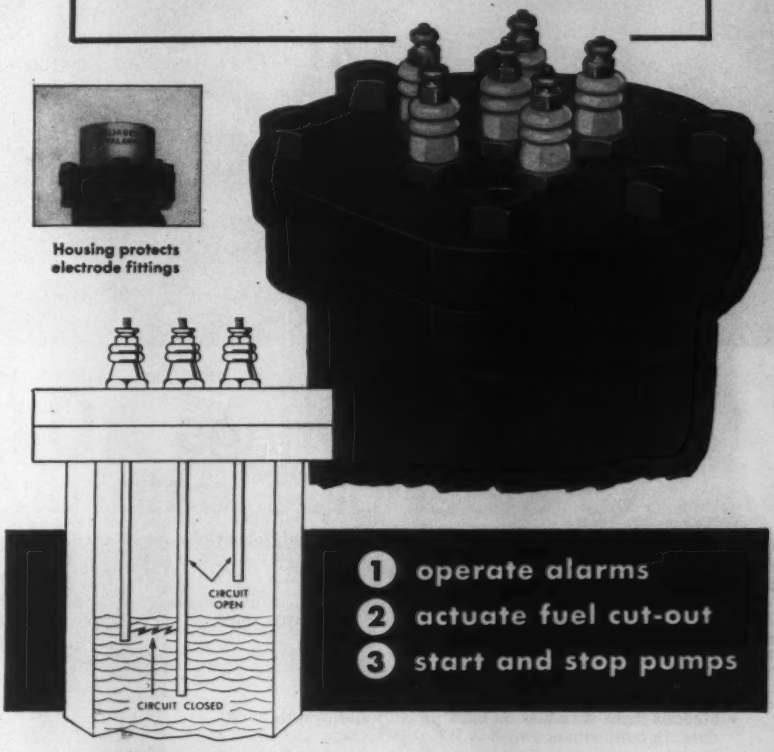

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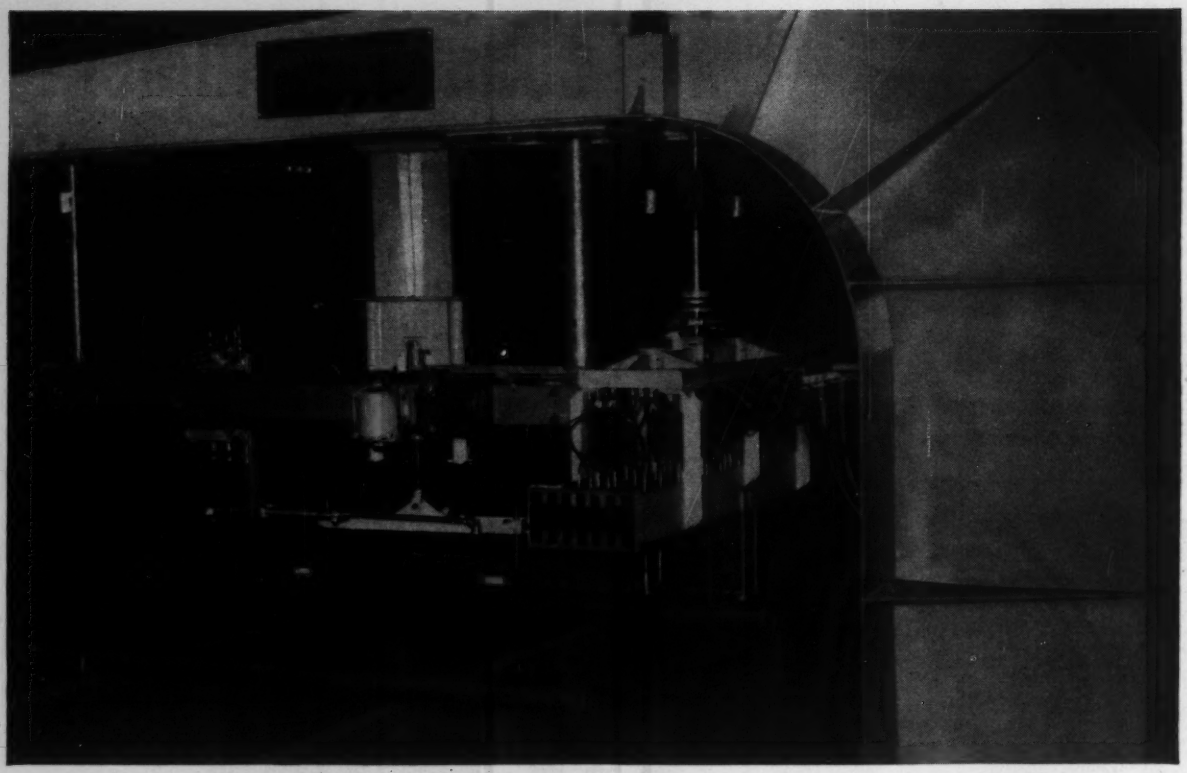

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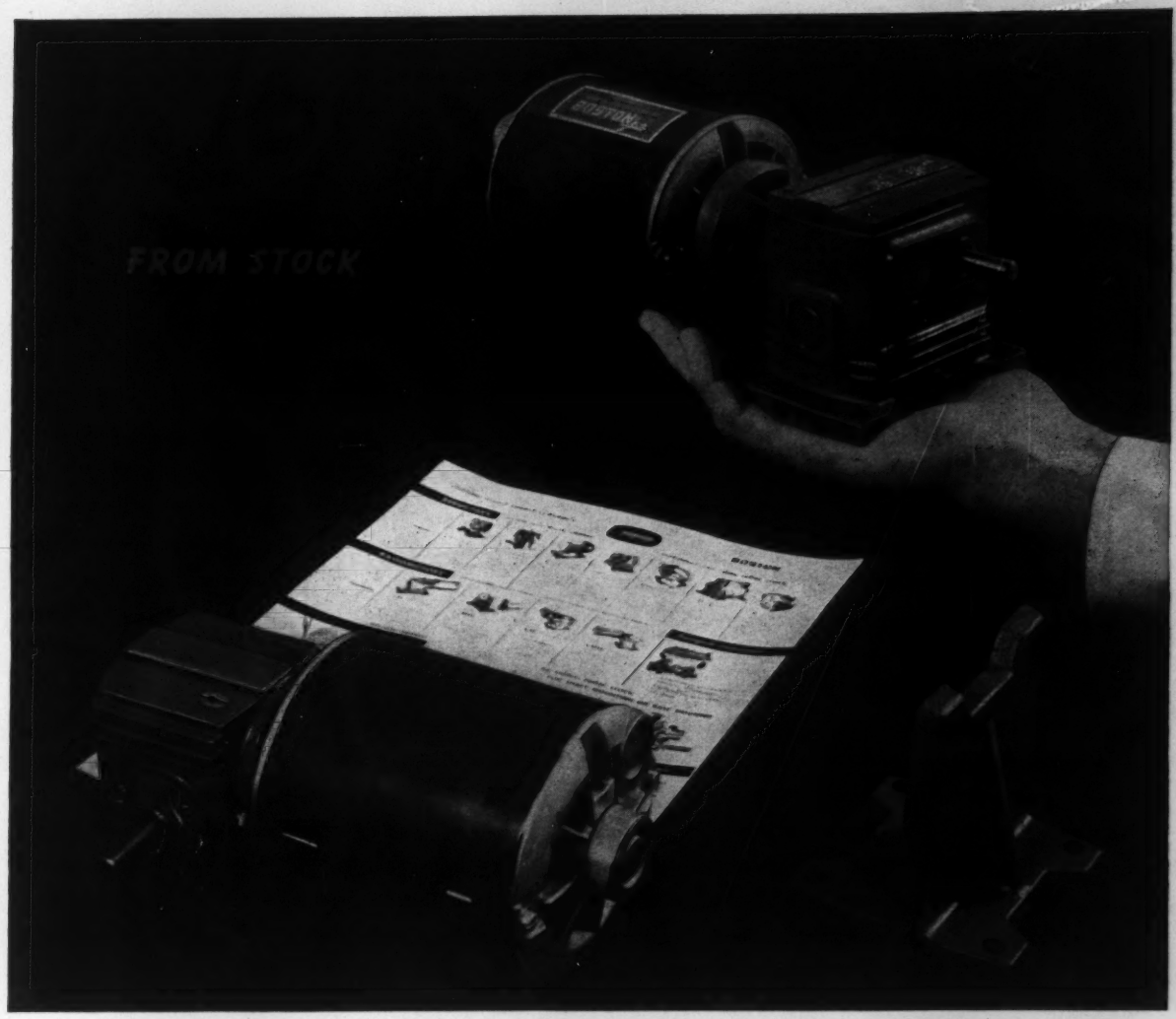

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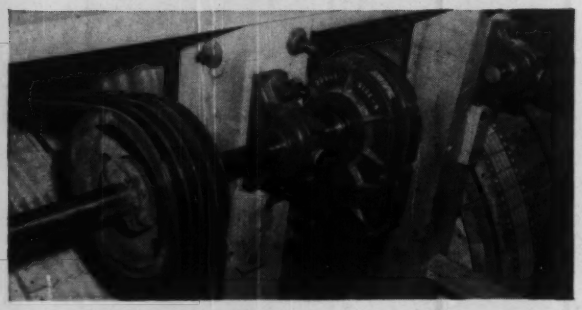
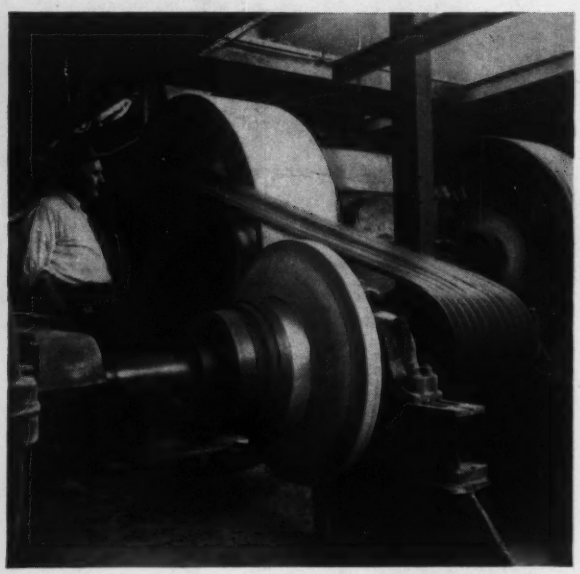
— STANDARDIZATION PAYS —

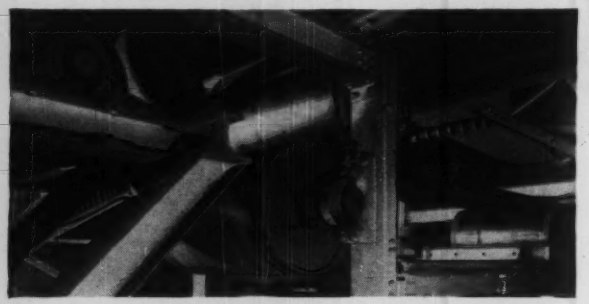
How Dodge pillow blocks with Timken® bearings give longer life with less maintenance



1. Two 2⅞" Dodge Special Duty pillow blocks equipped with Timken® tapered roller bearings, support the line shaft driving six by eight foot tanning drums. The tapered design of Timken bearings enables them to take both radial and thrust loads in any combination.



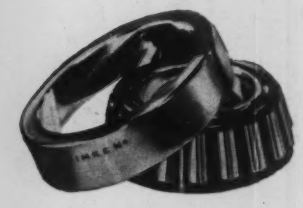
2. The crusher at a trap rock and asphalt plant runs faster, gives more production now that Dodge Double Interlock pillow blocks on Timken bearings are installed. The Timken bearings in these blocks give full-line contact between rollers and races for greater load carrying capacity.



3. The Timken bearings in All-Steel Dodge pillow blocks must stand up under adverse operating conditions found when sintering metals. One major advantage of Timken tapered roller bearings is their ability to hold housings and shafts concentric, thus keeping lubricant in, dirt and dust out.

The photo at right shows the Dodge All-Steel pillow block Timken bearing equipped. The specially designed bearing has a tapered bore with self-aligning spherical outer surface—never needs adjustment.

There's a Dodge pillow block equipped with Timken bearings to fill every engineering need: All-Steel, Type "E", Double-Interlock, Type "C" and Special Duty. And with Timken bearings, space consuming thrust devices are not needed. Look for Timken bearings in all the machines you buy or build. They're the symbol of quality. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.



BETTER-NESS rolls on

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